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SCIENCE

21 March 1958

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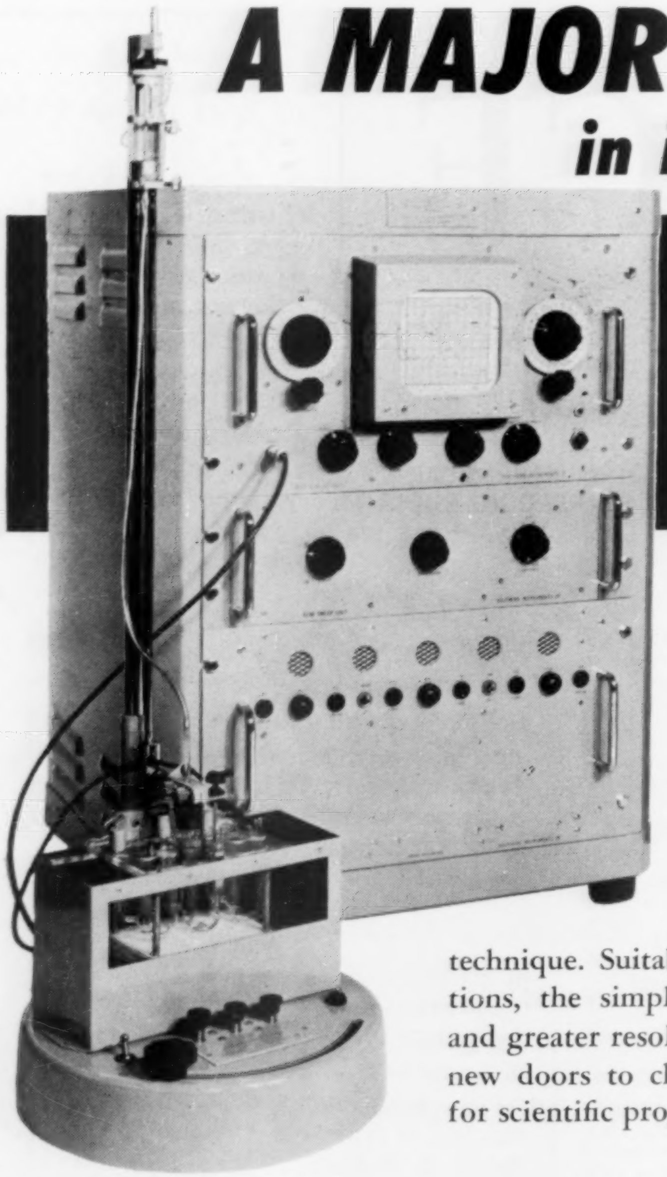

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B. J. MacNulty, G. F. Reynolds, E. A. Ferry. ANALYST (1954) 79, 190 and 938

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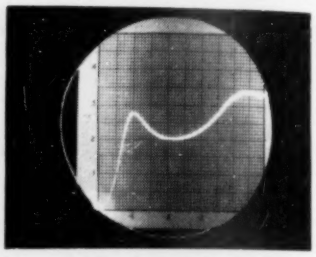

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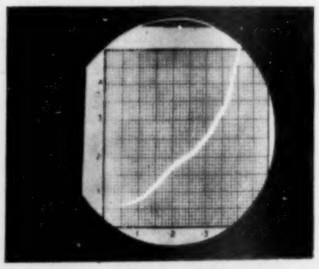
Mixture of isomeric nitro-terephthalic acids



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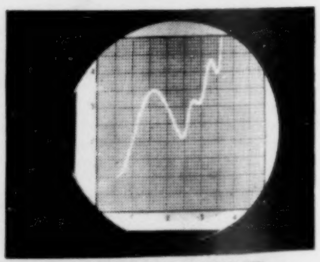

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Pitfalls of Prepublication

In recent years a new kind of informal publication has come to play an important part in the dissemination of scientific information: many scientists now follow the practice of mimeographing their articles and sending copies to selected colleagues prior to official publication. This practice has the great advantage of speed: the results are available to some of those concerned within days rather than within months, and the research process is correspondingly accelerated.

This is all to the good, but there are some disadvantages. For one thing, those researchers who are not on the list to receive the informal or fugitive publications are left in the dark about the latest developments unless and until regular publication occurs.

For another, there is the possibility of vexatious bibliographic confusion. This creates no problem when the mimeographed papers are already accepted for publication at the time of distribution. But a good many papers of this type are sent out with the notation that they have been or will be submitted to a certain journal. Here is a source of possible confusion, for, as most authors know, the relation between a manuscript and its appearance in print is analogous to that expressed in the proverb, "Many's the slip 'twixt the cup and the lip." The paper may be submitted and withdrawn, or submitted and rejected, or not submitted at all.

Thus, even though the paper may never be published, writers of other papers may list it in their bibliographies as "in press" in a certain journal, and the editor may be asked when such-and-such a paper is going to be published or even, "Why are you suppressing so-and-so's paper?"

What are some possible remedies? To lessen bibliographic confusion, authors should adopt a more skeptical attitude toward the phrase "in press." Does it represent a fact or a hope? To obviate the need for rapid spread of information by informal prepublication requires a fresh approach, for many journals are now publishing papers about as rapidly as editorial and mechanical limitations permit. Accordingly, we will watch with interest the outcome of a new approach to be tried out by the American Physical Society. The society plans to publish a new journal, the *Physical Review Letters*, at biweekly intervals. Letters or announcements will be published 10 or 11 days after the deadline for each issue; in addition, abstracts of articles scheduled for publication in the *Physical Review* will be published about 3 months in advance. The very rapid publication contemplated by *Physical Review Letters* will be made possible only by omitting some of the time-consuming steps followed—and quite rightly followed—by journals of primary publication. Thus, announcements will not be sent to referees, and authors will not receive proof.

We hope that this venture will succeed. If it does, it may reduce the need for mimeographed publications in physics. At the very least, it will give all researchers in that field an equal chance to keep up-to-date.—G.DuS.

The place of the Particle Accelerator in Basic Research...

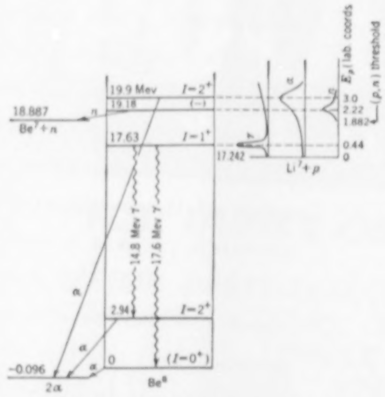
Particle Accelerators for Nuclear Physics Teaching - IV

Laboratory demonstrations of nuclear phenomena are invaluable in illustrating the problems that will be encountered by the student in nuclear physics research. They are a vital adjunct to classroom instruction in theoretical and experimental nuclear physics. The experiments themselves should illustrate the techniques commonly used for particle detection, as well as problems that will be encountered in vacuum systems, high-voltage breakdown, and general electronic and nucleonic instrumentation.

A most fruitful method for nuclear investigation involves high-energy bombardment of the target nuclei. A number of charged-particle accelerators are available for this type of work, one of the most useful and versatile of these being the Van de Graaff. High Voltage Engineering Van de Graaff equipment can produce homogenous beams of protons and deuterons with continuously variable energy. Accelerators are available with maximum energies of 0.25, 1.0, 2.0, and 3.0 Mev. These allow many heavy-particle reactions to be demonstrated, as well as several photonuclear reactions above 1.66 Mev.

Scattering Experiments

Proton-proton scattering experiments are readily carried out with hydrogenous targets, and can be used to demonstrate isotropic scattering in the center-of-mass system characteristic of s-wave interactions. The heavier nuclei in the target material will produce a different energy-angular relationship and thus demonstrate the effects of high-Z materials. Analysis of the data can illustrate the difference between the high- and low-Z materials, and show the departure from pure Rutherford scattering with low-Z targets.[1]



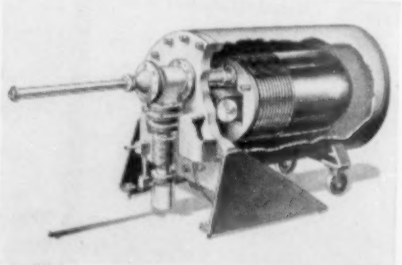
Energy-level diagram for Be^8 from (2).

Nuclear Reactions

Some typical reactions can be shown using a Li^7 target. The first two excited levels of the compound nucleus in the reaction Li^7 (p,γ) Be^8 can be determined by measuring the gamma rays emitted at the 0.441 kev resonance. Measurement of the energies of the alpha rays resulting from the disintegration of the Be^8 nucleus can be used to determine the angular momentum and parity of the excited nuclear levels. The energy-level diagram shows these levels[2]; the cross-section for the various reactions is sketched at the right hand side. Inelastic proton scattering of the incident protons can also be demonstrated and shows resonances at 0.8 and 1.04 Mev[3].

Neutron Production

Neutron production is also possible with suitable particle target combinations. The D-D reaction will produce neutrons with energies of the order of 2 Mev. The D-T reaction will produce neutrons with energies of the order of 14 Mev[4]. These fast neutrons can be used to demonstrate neutron-nuclear phenomena such as moderation, inelastic scattering, and capture with resultant radioactive decay.



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Typical experiments such as those described can be applied to show the student how to analyze experimental data, and how to use different types of particle and electromagnetic radiation detectors. They also bring to the attention of the student some of the problems which are still unsolved in the theory of the nucleus.

The advanced nature of the Van de Graaff accelerator design, suitable for teaching at the student level, also permits original research programs to increase man's understanding of nuclear phenomena.

Write to HVEC for a set of typical experiments which can be performed with pulsed or continuous neutron sources.

References:
1. The Atomic Nucleus, R. D. Evans, p. 338, McGraw-Hill Book Company, New York, 1955.
2. F. Ajzenberg, T. Lauritsen, Revs. Mod. Phys. 27, 77, 195
3. Brown, Snyder, Fowler, T. Lauritsen, Phys. Rev. 82, 159, 1951
4. A. O. Hansen, R. F. Taschek, J. H. Williams, Revs. Mod. Phys. 21, 635, 1949

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21 March 1958, Volume 127, Number 3299

SCIENCE

Human Values in Relation to Evolution

If genetic natural selection applies to likes and dislikes, what is the true status of values?

H. J. Muller

By something of value we mean, of course, something desirable, to be striven for, and from the attainment of which we presumably derive satisfaction. The value of a thing, in other words, is its property of being desirable. If it is undesirable, its value may be said to be negative. By these definitions, all animals that can pursue conscious purposes recognize values in given situations, values partly built in as such and partly channelized and modified by experiences, and these values are of different degrees, so that they could be represented on a scale. Probably only man, however, of animals on this earth, has reached the stage of pondering over values, and singling them out, as it were, by speech symbols. And so only he has attempted classifications for grouping things of related value together and has arranged these groups in hierarchies, with higher rank accorded to those expressing certain general psychological principles, such as heroism or truth. Nevertheless, even the nonhuman animal, like the young child, often acts according to much the same principles, but without abstracting them.

When the matter is regarded in this way, it becomes evident that values are as legitimate a subject of scientific investigation as any other phenomena pertaining to living things. In fact, it is imperative that they be investigated by scientific methods if we would seek greater clarity and assurance regarding our own aims and if we would order and shape these aims in such wise as to attain, in human living, a more harmonious interplay of strivings and of activities, and a deeper sense of fulfillment. The pursuit of this project, however, has unfortunately been hampered by the prevalence of two tenets that are incompatible with it. The earlier, historically, of these tenets holds that values for man are properly determined only by some higher authority, external to him. The second tenet, often thought of as an alternative to the first and yet related and reconcilable with it, holds that, for each individual, questions of value are purely his own private matter, shared only with those who already agree with him, as in the case of some schools of artists, and that these questions cannot profitably be argued about. My discussion is not directed to those who are irrevocably committed to either of these views.

Biological Significance of Values

There are no grounds in evolution theory for regarding the likes and dislikes of nonhuman animals, their emotional reactions and drives, or their resultant desires and values, as being determined by processes any different in essentials from the evolutionary mechanisms whereby their other characteristics were laid down. The same principles of blind mutation, genetic recombination, and natural selection as have been inferred to underlie the evolution of other physiological as well as morphological peculiarities are equally applicable to the genesis and establishment of the so-called affective traits. It is therefore not surprising that the present-day emotional and affective equipment of any species provides the basis for an intricately interrelated web of responses that are all nicely adjusted to the service of the same major end—species survival and expansion—even as is true of all other bodily functions.

This by no means implies, however, that each species is constructed in the best possible way for leading its own kind of life in its own kind of niche nor even that there is any one best way for doing so. For of course the products of evolution, although displaying within themselves amazing coordination, are patchworks thrown together bit by bit without long-range foresight. Time and again they have had to be remodeled opportunistically, in one small way after another, as new emergencies or opportunities have arisen. Undoubtedly, if the organisms could have been made from blueprints designed from the first to enable them to lead their present types of lives under their present circumstances, diverse disharmonies, indirections, and complexities that are now incorporated solidly in their structures could have been avoided, with considerable gain in effectiveness.

In the case of a species which, like man, has changed its mode of life rather recently, in terms of geological time, the remodelings are still relatively crude, conspicuous, and on occasion troublesome. Thus more friction, both inner and outer, would be generated in such species than in the far more numerous ones that had kept running in pretty much their old established ways. All this may

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The author is Distinguished Service professor in the department of zoology at Indiana University, Bloomington. This article is based on the concluding address in a symposium, "Human Behavior in Relation to Evolution," sponsored by the Society for the Study of Evolution and cosponsored by the Genetics Society of America, which was held at Stanford University, 27 August 1957.

be expected to hold in the realm of "behavior," including that of desires and values, just as it does in the other modes of functioning of the organism. However, in higher forms and more especially in man, the plasticity of their behavior would tend to conceal defects in its bases.

A consideration of the values that, in any species, are attached to diverse experiences, in situations involving relatively little modification by conditioning or association, necessarily involves some understanding of the entire complex system of drives, response potentialities, thought processes, and sensations, along with the affective mechanisms, including emotions, attached to these activities, in a creature of the given type. Science is at present woefully far from a detailed analysis of these matters. It has been generally conceded that in insects there are indeed a multitude of highly particularized and often intricate patterns of behavior that are to a very large extent genetically determined. Moreover, fish and especially birds are hardly behind insects in this respect, even though their reactions are more open to modification by experience. In the case of mammals, it has been widely held that the genetic behavior patterns are less specific, both in regard to their instigating stimuli and to their methods of response, and that in man they have virtually disappeared, to make way for reactions determined almost completely by experience.

Closer scrutiny shows, however, that despite the enormous increase in the effectiveness and complexity of associations in man, his nature provides him with a great number of unlearned predilections and aversions. These range from those on a purely sensory level, such as a liking for sweets, diverse savories and fragrances, feelings of softness and smoothness, warmth, harmonies, color combinations, varied kinesthetic and other bodily feelings, and so forth, and a dislike for their opposites, to those on a perceptual and perhaps even a conceptual level.

Genetically Based Differences in Values

Of course perceptions and conceptions are gained only by learning. Yet, curiously enough, individuals display marked inheritable differences in regard to the strength of feelings attached to certain concepts, such as the feelings that have been denoted by the terms *egotism* and *sociability*. For example, it requires considerable experience, analysis, and association of sensations and perceptions before one arrives at the concept of one's self and of other selves, yet it seems much as if there were a mechanism lying in wait to attach positive affective values to these concepts when or shortly after they appear. Perhaps this effect represents only the combination of the values already attached to the components of the concept, plus those later added by association. However that may be, self-esteem may become developed much more strongly in one person than in another even though the experiences of the two seem to have been essentially similar, and even though one may seem to have had no more attachment for the separate elements out of which the ego conception was built than the other person has had.

We are far from understanding the built-in mechanisms by which such results come about, but their efficacy is attested in varied ways, both in man and in other more-or-less intelligent animals. Among dogs, for instance, such differences in temperament, as we call them, have long been observed to be associated with particular breeds, even when the young are taken from their parents so early that the behavioral traits in question could not have been acquired purely by experience. At the same time, an acknowledgment of this situation should not lead us to minimize the enormous role of experience, especially in man, in channelizing and shaping the modes of expression of these feelings, and in determining what situations call them forth.

It would be presumptuous and fatuous, in our present ignorance, to attempt here to list or classify the numberless inherent affective tendencies—that is, natural predilections and aversions—observable in mammals, the great majority of which also appear to be present in some degree in man. It should be noted, however, that in those classifications that include only a few general categories, such as fear, anger, love, and curiosity, each item really represents a complex group of natural tendencies that are in some manner related. For instance, under fear would come fear of heights, which recent experiments with nonhuman mammals have shown to be expressed in them in the absence of previous experience, and which undoubtedly evokes somewhat different emotions as well as responses from those found in other innate fears, such as fear of loud deep tones having the quality of thunder or a growl. Again, sexual love is itself very complex in its inherent basis, and although it has elements in common wi or similar to those in the parental, filial and communal forms of attachment, i is misleading to represent it as differentiated from the others, or them from one another, solely as a result of experience. Moreover, in addition to the inherent affective tendencies included under a few general headings such as those mentioned, there are many that do not fi under any of them, such as those tha participate in our multiform experience of beauty and revulsion, of exhilaration and depression, and so on.

Finally, it should be realized that, contrary to the assumption of some authors the fact that a given psychological trai appears later than at birth by no mean affords evidence that it is purely a acquirement gained by experience. Inherent affective traits, like all other characteristics of organisms, tend not to attain manifestation before a given stage peculiar to that trait. However, becaus of the enormous influence that is als exerted by experience in the manifestation of traits, the disentanglement of th processes at work in the case of a give trait often becomes very difficult.

Despite a large amount of agreemen between different species of mammals i regard to their constellation of affecti tendencies, and the way in which the attain expression, there are of cours considerable differences between specie and even subspecies in the relativ strengths of these tendencies, in thei mode of expression, and, more especially, in the stimuli that evoke them, i adaptation to the differences in the organisms' modes of life and capabilitie To this extent, each type of creatur pursues somewhat different values fro the other creatures and different immediate aims. It pursues some of these fo their own sake, with due compromis amongst them. These subjective end are so adjusted that, for each species an subspecies of animal, although of cours not for each deviant individual, this compromise tends to work in the directio of the ultimate objective end of the species: its maintenance and spread. Bu the creature does not recognize this en as such, nor does it recognize even th more limited end of "self preservation that is popularly attributed to it.

Genetic Foundation of Altruistic Value

Of course, the subjective ends of creature may be far from purely selfis First Darwin, and later Kropotki pointed out that natural selection is n just a tooth-and-claw struggle. Insofar as cooperative behavior furthers survival, natural selection has promoted emotional bonds and a spirit of service among members of the same family and the same community. However, this form of selection is limited to situations in which an individual, in helping others, by these very acts somehow assists in the survival of its own genes, or of the same or similarly acting genes in the other individuals—that is, genes of the type that led to these cooperative acts. Obviously the nurturing and protection of the young belongs in this category, since the individual is thereby fostering genes derived from itself. However, many ways of life put a premium on early dispersal of the young and in these cases maternal care is kept minimal. Similarly, "rugged individualism" rather than altruism among adults would tend to win out in the numerous species in which dispersal of adults is advantageous, or in which means of mutual aid, in the sense defined above, are hard to come by.

Fortunately for the mammals, their mammary glands, apparently originally derived from the more generalized sebaceous glands that serviced their fur, provided a ready means of nourishing the young, and thus laid the physical basis upon which a high development of all the maternal impulses, including especially maternal love, became practicable. It is evident that in many cases some extension, with suitable modifications, of these feelings and modes of response to the relations between father and young, father and mother, and finally among all immediate relatives, must have proved helpful to the propagation of the genes concerned in these developments. Under certain circumstances, including those of ground-dwelling primates, which are relatively defenseless individually, there proved to be comparative safety from predators in numbers, and also other advantages, as in hunting, when it emerged, in sharing fire, and in sharing services and abilities. From then on, genetic variations leading to associations among families, and to a partial extension of the affective family ties to the other members of the community, were rewarded by enhanced survival and multiplication. All this meant a step-by-small-step development of the genetic bases of social feelings and behavior—that is, of the complex sometimes comprised under the term *brotherly love*.

It is important to note, however, a self-limiting feature of the genetic process underlying this development. So long as the communities are small, variants having genes that predispose them to helping the members of other families will be able appreciably to foster the survival and spread of their community as a whole. This community, being small and interrelated, will usually contain a higher proportion of genes of the type in question, that lead to this cooperative action, than another community in which there is less cooperation and which therefore is less successful. Thus the cooperative individual tends to further the survival and spread of genes like his own even though he himself is sacrificed. However, as this very process and the cultural evolution attending it cause these groups to grow larger, the power of this strictly *inter*-group selection diminishes. Perhaps the resultant slowing down of natural selection for social traits affords a partial interpretation of the relatively low development of the broader social impulses in present-day man.

As has often been pointed out, social insects which have only a few reproducing individuals per colony do not suffer from this self-limitation of natural selection for social traits when the number of sterile workers per colony increases. These workers represent only somatic extensions of a very restricted colonial collection of genes. Thus the gene composition has the high inter-colony variability of small numbers, and a high degree of self-sacrificing behavior on behalf of the colony reflects and tends to perpetuate and spread the kind of genotype that has produced this behavior. In this way these insects have been able to attain a far higher degree of *genetically based* socialization than has man. Nevertheless, their potentialities are of course far more limited, by their inordinately lower intelligence and capacity to learn, their inability to accumulate culture, and their inability to attain a realization of what the fuss is all about.

It has sometimes been held, as for instance by some schools of Communists, that the development of social feelings in man is merely an expression of enlightened self-interest associated with his intellectual, technical, and cultural development, without any important basis in his inherent affective or emotional peculiarities. A genetically asocial but intelligent man, if already living in a group where social feelings and practices prevailed, would doubtless try to camouflage himself, for his own good, into a seeming replica of his fellows. But this would not prevent the lone wolf in sheep's clothing from practicing self-aggrandizement at the expense of others wherever he judged he could get away with it. A community of such individuals could not hang together indefinitely. Still less would they *voluntarily* organize themselves into a socially behaving group, devoid of genetic sheep. The advantage of mutual aid to a group thus depends in the main upon its individuals practicing it even where they themselves do not reap any profit other than the intrinsic reward of such acts to those for whom such behavior is a primary end. Once such a feeling is present, however, its expression can be reinforced by various accessory motivations, such as pride in following out the rules of the community.

Cultural Elaboration of Values

We cannot enter here into the manner in which, in increasingly intelligent animals, the pattern of behavior, and of affective tendencies, is more and more modified by experience. Still less can we here review the truly revolutionary innovation in method whereby, in man, experience becomes transferred, symbolized in speech and otherwise, accumulated, codified, and sanctified. It is important, however, to realize that it is a function of these processes of modification, whether by individual or by group experience, to extend the inherent affective tendencies to situations which the experiences have shown to be somewhat connected with the ones that originally aroused the given feelings. Thus, for each individual or, where experience is transferred, for each group, a pattern of feelings and responses becomes built up that has, so to speak, been recut so as better to meet the set of circumstances peculiar to that individual or group. Yet the old feelings are in large measure still there, and in many cases they are still evoked by the original stimuli, as well as by the associated ones.

It is true that the associations form extended chains, or rather webs, yet the motivations that trigger the decisions to act or not to act are in the last instance based in the ingrained affective components that are directly or indirectly attached to elements in any given web, and that have now become more or less suffused throughout that web. It should also be noted that, within any web, not all affective components need work in the same direction. Thus the attainment of the final decision may entail considerable inner friction.

The transfer and accumulation of experience—that is, cultural evolution—

was of course possible only because of the intelligence, social disposition, and manipulatory, vocal, and other special proclivities of genetic origin that had laid a basis for it. For a very long time, while culture was being accumulated, this genetic basis also must have been strengthened by natural selection, and the cultural process must have been facilitated thereby. More recently there has probably been a slowing down of the genetic advance, caused by the formation of fewer, larger groups and by the greater efficiency of mutual aid in helping the less fit.

Another factor that must have facilitated cultural evolution in the past is a kind of nongenetic natural selection operating between different groups, and between portions of a group, so as to favor more the continuance and spread of those whose cultures (as distinguished from their genes) were more conducive to their own survival and increase. This process, emphasized in its intergroup aspects by S. J. Holmes, tended to promote the more functional cultures and to curb the biologically unsounder ones that went off on cultural tangents by a kind of inner inertia. Undoubtedly this natural selection of cultural features also went on within the group, to favor the survival and multiplication of those whose traditions of value and conduct were more functional, even as, within our own society, the Shakers, whose religion forbids them all to reproduce, have virtually died out. The situation is of course different with a celibate priestly caste since this is automatically replenished from the rest, although it can of course result in the gradual depletion of superior genetic material in the group as a whole.

Nevertheless, the development of culture proceeds primarily through its own operations. Although the core of these is the joint accumulation of experience, most of that experience until modern times has consisted of purely empirical observations and familiarity with rule-of-thumb operations, with little understanding of the nature of the matters involved. The artificial interpretations, almost always animistic, that were gradually fabricated regarding the nature of the world and man, and the associated rituals, witch-doctoring, and institutionalization of superstition, did however fill the important general function of reinforcing the social solidarity of the group and promoting their cooperative behavior. They also played important technical roles in healing, in advantageously regulating hunting, planting, and so on, and in laying down rules of conduct that were made to seem dependent on the interpretations themselves. Our modern scientific knowledge makes the intellectual fallacies and the technical imperfections of these primitive systems so glaring that we tend to forget the positive role they played until we see a primitive people lose all interest in life and disintegrate when modern civilization deprives them of their Rock of Ages.

The religious and ethical systems of nonscientific peoples expressed the values that they overtly recognized, but in doing so they gave opportunity for the satisfaction of the peoples' actual affective needs and resulted in behavior conducive to the survival and extension of the group. Despite marked differences among these systems, in viewpoint and methods, remarkable similarities are also displayed, especially among the more successful ones, reflecting the underlying likenesses in human psychological and physical needs, combined with plasticity in adjustment to these needs.

All the more successful social systems emphasized by precept and training the importance of service to others, not only in the family (which of course had priority) but also in the group as a whole, and, later, more especially, to the leaders. Moreover, those specific attitudes and practices were fostered that tended to make that service more effective: practices such as veracity, integrity, self-control, industry, and courage. In addition, devices were used for arousing ecstatic emotional experiences that deepened and intensified the individual's sense of forming a part of a greater family, dominated by a greater father, who provided greater rewards and more frightful punishments. These experiences also enhanced the individual's sense of privilege and achievement in participating in the activities of this supernal fellowship.

Revision of Values under Civilization

Until some 2500 years ago community loyalty was usually accompanied by a then healthy suspicion and even hostility toward other communities, especially those with different cultures, and often by a zeal in striving against them that matched and nourished the intragroup cohesion. But with the rise of the great empires that embraced many previously separate peoples, doctrines of brotherhood among all mankind began to gain increasing acceptance. Along with this there was a growing adherence to abstract conceptions that were supposed to embody universally valid higher values, such as Plato's "Goodness, Beauty, and Truth." However, these terms were seldom defined concretely enough, in view of the innumerable interpretations which could be given them, to provide unequivocal solutions to problems of actual living on the part of either the individual or the group. Thus, Plato regarded slavery as fundamental for his system of Goodness, Beauty, and Truth.

It is high time for modern man, everywhere, again to revise his concepts of values, in accord with the utterly new view that science, and especially evolutionary science, has given him of the nature of the world and of his actual and potential relations to it. We must admit that it is much too early for detailed formulations of the place to be accorded to the diverse major and minor values that flow out of his numerous inherent affective tendencies and out of the possibilities of interconnecting them, modifying their modes of instigation and expression, enhancing some and subordinating others. For this purpose we have as yet far too little knowledge of just what these tendencies are, and of their genetic and acquired variations, in neurological, psychological, and sociological terms. Yet we can already discern clearly certain major features that lead to important general conclusions.

Man is not made with any one inherent affective tendency or drive and associated value, that can normally provide a clearly overriding aim for all his existence. It is true that *deprivation* of the opportunity to pursue a given drive may cause its value to become overriding. But be this drive sexual love, love of offspring, of his fellows, or of himself, be it joy in domination, or in subordination, be it love of variation or of the familiar, or of good eating, or anything else, man is normally a great bundle of natural and acquired wishes and values, interrelated in a pattern that is partly individual but very largely a product of his group's cultural evolution, including the contributions made by great and little thinkers of his past. This entire complex has in its general lines been framed so that the working of this system tends on the whole to promote the survival and multiplication both of his family and of his larger group. Thus his values tend to be realized more fully when this objective end, even if not understood, is promoted by him.

It is natural that this should be the case, since in the first place natural selection has worked to provide him with predilections and aversions that under primitive conditions would combine to lead to this result. In the second place, his culture has on the whole worked to modify the directions of these wishes and struggles so as to lead to this result under the conditions of that culture. In recent times, however, human understanding and the conditions of human living and association have been changing so fast that our systems of values and ethics, education, and social relations have fallen behind and are not well enough adjusted to our present needs and knowledge.

What kind of reorientation is needed? Obviously, one in which our motivations are reshaped in accordance with our modern knowledge of the world and ourselves.

Among the deeply and complexly rooted inclinations of men is their readiness to accept the challenge of any situation confronting them, if it affords a hope, through struggle, of winning through to greater life for themselves and for those with whom they identify themselves. With the shrinkage of the world, and the suicide that is being committed by war, if it does not murder us first, each man must ever more strongly identify himself with humanity in general. The visions that he has obtained of the unimaginable progression already accomplished in past evolution, of the unprecedented powers which he himself has now gained through science, and of the fathomless reaches to which man may go, in terms of greater life, by the rational use of these powers in behalf of himself and posterity, afford an overall directive for his efforts that is in accord with the objective end of the species—namely, its survival and extension—and also with most of his own more immediate subjectively based values. Enough can thereby be gained for the individual, in enhanced richness and harmony of life, to recompense him on a personal basis to a degree unparalleled in the past, especially if we will take advantage of already existing psychology and psychiatry. At the same time, he can attain a sense of participation in a joint endeavor far greater than his own that is more solidly based and more buoying to his spirits than that gained by obedience to a tenuous superior power.

As between individual and social values (or welfare) there is no ultimate contradiction for beings who have the natural feelings that lead to mutual aid. However, until we have gone further in the development of these feelings, through both training and genetics, there will be many situations calling for difficult compromises on our part. It is important in such connections to remember that those men who have had better opportunities for all-round development and zest in life, as a result of their personal experiences and activities, and who have a significant voice in the determination of their own destinies, can also give better service to the community.

Higher Values

It may here be objected that we have not yet given an opinion as to what should be considered the higher subjective values that are most to be striven for. If objectively we take survival and extension of the species to be the end, as set by evolution, then we find that in our own line of descent the two groups of psychological characteristics that have been the most important in putting us into our dominant position were those making for intelligence and those making for cooperative behavior. Moreover, despite the revolutionary changes wrought by our culture since its creation of modern science, it is evident that these two functions, especially when enhanced through cultural measures and, I believe, eventually through genetic measures also, will *continue* to provide the most important means of meeting the evolutionary test of survival and extension, while at the same time they will render us ever more capable of filling not merely our physical but also our psychological needs—that is, of achieving and advancing our values.

In accordance with this thesis, we may place in the foremost positions among psychological needs, and we may accord the highest value to, for one thing, the gratification of curiosity—that is, the pursuit of truth for its own sake, by methods of the most effective kind (the kind used by science)—and, for another thing that is no less important, the fulfillment of love in its varied aspects. Among other values, the cultivation of which is also highly important, we may mention here as a few examples, largely overlapping with one another and with the two already given, the zest for making one's own decisions (that is, for the exercise of freedom), for achievement, creativity, variety, and adventure, and the appreciation of nature, art, and artifice. All of these overlapping values can be harmonized with one another, and the seeking of them will play major functional roles in our objective as well as subjective progression.

It has been rightly said that biological evolution is multidirectional and cruel and that the vast majority of lines of descent end in pitiful anticlimaxes. Yet it is also true that intelligence and cooperation, culminating in ourselves, have not merely constituted one of the lines of nature's development, but *the* one which, through its increasing control of the rest of nature in its own interests, has become by far the most prominent. But this development is only beginning. It is our business to take it as much farther as we can, in the creativity of our coordinated, voluntary efforts. Through the unprecedented human faculty of long-range foresight, jointly serviced and exercised by us, we can, in securing and advancing our position, increasingly avoid the missteps of blind nature, circumvent its cruelties, reform our own natures, and enhance our own values.

The foregoing conclusions represent, I believe, an outgrowth of the thesis of modern humanism, as well as of the study of evolution, that the primary job for man is to promote his own welfare and advancement, both that of his members considered individually and that of the all-inclusive group, in due awareness of the world as it is, and on the basis of a naturalistic, scientific ethics.

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Effects of Radium in Man

Pending more data, it seems advisable to lower the concentration level now permitted in the body.

William B. Looney

The maximum permissible concentration (MPC) for such radioelements as strontium and plutonium is indirectly based on the results of the studies of the effects of radium in man over the past 34 years (*1–12*). The first report relative to the establishment of the present MPC of radium of 0.1 microgram in the body was published by the U.S. National Bureau of Standards in 1941 (*13*). Seven individuals who had had from 0.02 to 0.5 microgram of radium in their bodies for periods of time varying from 7 to 25 years had no observed changes referable to the deposition of radioactive materials. Death attributable to the effects of radium occurred in patients having as little as 1.2 micrograms of radium. The MCP was set at 0.1 microgram, which incorporated a safety factor of 12.

The results of two large investigations, published recently, show that roentgenographic skeletal changes began to occur at concentrations of 0.4 microgram of total body radium, major skeletal damage at 0.7 microgram of total body radium, and bone tumors at 0.8 microgram of total body radium (*6, 10*). It is reassuring to find that it has not yet been necessary to change the MPC of radium of 0.1 microgram in the light of the large amount of information that has accumulated since the MPC was first established. However, the present data, accumulated over the past 34 years, on the effects of radium in man, when extrapolated to cover a period equivalent to a normal lifetime, indicate that "appreciable bodily damage" (*14*) may occur at, or below, the present MPC of 0.1 microgram.

It seems advisable to lower the present MPC of radium now, until information is available on the effects of radium in man for at least one life-span, for the following reasons: (i) the present information on the reliability of the MPC of 0.1 microgram of radium in the body is inconclusive (*14–17*); (ii) no information on the effects of radium in man retained in concentrations at or near the present MPC for a period longer than 40 years is available (*6, 10*); and (iii) the roentgenograph, the most sensitive clinical means for detecting skeletal damage, is an inadequate method for detecting histopathological changes (*11*).

The International Commission on Radiological Protection (ICRP) has recommended that the average dose rate to the gonads and total body be less than that provided by 0.3 rem per week. The ICRP and the National Committee on Radiation Protection and Measurement have now proposed to limit the accumulated absorbed dose to one-third the integrated basic rate. The mean radiation dose from the present MPC of radium of 0.1 microgram is calculated by the ICRP to be 0.56 rem per week (*14, 16, 18*). The term *permissible dose* is defined by the ICRP as the dose of ionizing radiation which, in the light of present knowledge, is not expected to cause appreciable bodily injury to a person at any time during his lifetime. The term *appreciable bodily injury* is defined as "any bodily injury or effect that a person would regard as objectionable and/or competent medical authorities would regard as being deleterious to the health and well-being of the individual" (*14*). The ICRP has recommended that exposure to radiation in the geographical neighborhood of controlled areas be limited to one-tenth of the occupational exposure, and that the exposure of the population at large should be of the order of the radiation in the natural background (*14*). Therefore, the discussion of the MPC of radium will be limited to discussion of utilization of that concentration for the MPC of occupational exposure.

Four means of interpreting the term *appreciable bodily injury* will be considered in this article—namely, microscopic skeletal changes, roentgenographic skeletal changes, major clinical damage, and neoplasia. The reliability of the present MPC will be discussed with regard to these four interpretations. When possible, an attempt will be made to determine whether "appreciable bodily damage" will be expected at any time during an individual's lifetime as a result of the fact that 0.1 microgram is currently established as the maximum permissible concentration of radium.

Radiation Dosimetry

The determination of radium content in the body is made by collection of radon in the breath and by the determination of the gamma ray activity from the decay of radon and its daughter products in the body (*4, 6–9*) (the error in such determination of total body radium probably does not exceed plus or minus 20 percent) (*9*). One of the difficult factors in the correlation of radium content with skeletal change is time of retention. The relationship of radium burden to time was not positively introduced as a factor until recently (*9*). Physical measurements of the retained radium were made from 10 to 35 years after deposition in the recent Boston-Chicago studies. It would, for example, be difficult to take time into consideration in making a comparison of the clinical effects of 1 microgram of radium in the body for periods ranging from 10 to 35 years in a large group of patients.

Estimates of the accumulated radiation dose from radium have been made from data obtained from 20 patients in a mental institution (*5, 7–9*). These estimates have been based on the expression of retention as an approximate power function of time, with an exponent of about − 0.5. By utilization of this power function, the total accumulated radiation dose can be related to the radium burden at the time of measurement. The total dose is twice the product of the burden at that time and the time after injection (*19*). For example, if a patient was found to have 1 microgram of radium 20 years after administration, then

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the accumulated radiation dose, from the 1 microgram in the skeleton for 20 years, would be about 600 rads. The radium content of the mental patients at 1 year was about four times the radium content at 20 years. The total accumulated dose would be about 1200 rads. Thus, the additional 600 rads takes into consideration the radiation dose from the radium which was eliminated over a period of 19 years.

In the middle-aged patients, the loss of radium retained for 20 to 30 years should be small over the remainder of their normal lifetime. The available data on human beings show a decreasing coefficient of elimination of radium with time after administration (*9, 20*). For example, the mental patients cited above excreted only about 0.008 percent of the radium in their bodies per day about 20 years after administration. It would even be possible to disregard excretion over the next 20 years in these patients for purposes of dose calculations without the introduction of too large an error. If we assume that the above expression for retention as a power function of time is valid, then only about 20 percent of the radium in the patients at age 50 will be lost in the next 20 years. Therefore, subsequent calculations will be based on the above expression with a reasonable assurance that no large error will be introduced. Thus, the estimated accumulated radiation dose from 0.1 microgram of radium in a patient aged 70 years who had been given an unknown amount of radium at 18 years would be of the order of 300 rads (Table 1). The accumulated radiation dose from 0.1 microgram of radium maintained constant in the skeleton from 18 to 70 years would be of the order of 150 rads (Table 1).

Determination of the accumulated radiation dose permits a direct correlation of a quantity of radiation with skeletal damage during the time of retention. However, one of the major limitations is the variation of the retention of radium in the mental patients, from which data the mathematical expression of the accumulated radiation dose was derived. The retention of radium in these patients was determined 6, 12, 233, and 258 months after administration. Most of the values were within a factor of plus or minus 2 of the mean retention (*9*). However, the smallest amount of the injected dose of radium retained was about one-sixth as much, and the largest amount of retained radium about four times greater, than the mean retention in the 20 patients (*21*). The variation in retention should be kept in mind when the reliability of the estimates of the accumulated radiation is considered.

Estimates of the radiation dose in this article have been computed on the basis of an average energy dissipation of 11 million electron volts (Mev) for each atom of radium disintegrating (*22*). Only alpha radiation is considered, and since this radiation is primarily confined to the skeleton, no other organs are considered in the dose calculations. The accumulated dose from 0.1 microgram of radium in the skeleton of a 70-kilogram man (weight of skeleton, 7 kilograms) in one year is estimated to be about 3 rads. The value of 3 rads per year for 0.1 microgram of radium will be used in subsequent calculations.

Estimates of the mean radiation dose to the skeleton are based on the assumption that radium is uniformly distributed throughout the skeleton. This is obviously not a satisfactory assumption, because the radiation dose to bone in small areas of high radium concentration is many times the mean radiation dose (*23–26*). However, to correlate areas of maximum radium deposition with bone damage would be very difficult. The status of bone many years after radium deposition is the end-result of the pathological process rather than a concise picture of the relation between deposited radium and histology at the time of examination (*11, 25, 27*). Because of these limitations, the term *estimate* will be used in subsequent discussions in correlating either the total body content of radium or the accumulated radiation dose with skeletal damage.

Mesothorium Contamination

Mesothorium (Ra^{228}) is an isotope of radium which was used in the manufacture of luminous dials. In some of the workers in factories where luminous dials were made, the radiation dose from mesothorium was much greater than the radiation dose from radium (*6, 12*). Mesothorium has also been found as a contaminant of the radium solutions used medically. However, all information at present indicates that the mesothorium content of the radium solutions given

Table 1. Minimum radiation dose and skeletal change.

Patient	Latent period (yr)	Total body radium (µg)	Radiation dose* (rad)	Comments
		Roentgenographic change		
Skeletal roentgenographic changes characteristic of radium toxicity.	20	0.4	500	See *10*.
		Major skeletal damage		
Patient with lowest radium content.	22	0.7	1000	See *10*, and case history in text.
Mental patient with lowest radium content.	9	1.6	1300	Two patients of the series of 19 mental patients had major damage of the femoral heads. These patients were considered to have been given "pure radium" (See *10*).
		Neoplasia		
Radium-treated patient with lowest total body burden.	24	0.8	1100	Estimated accumulated radiation dose from mesothorium was 50 rads (See *6, 40*).
		Radiation dose		
0.1 microgram of radium, maintained constant from age 18 to age 70 years.			150	
0.1 microgram of radium found at age 70 years. Unknown amount given at age 18 years.			300	

* Estimated accumulated radiation dose from radium only.

medically were small. The initial mesothorium content of some of the radium ampules examined, which were prepared for medical use 25 years ago, could not have exceeded 0.66 percent (*9*).

The patients who received radium medically are the primary source of material utilized in this study for evaluation of the relationship between radiation dose from radium and skeletal damage. Therefore, the contribution of mesothorium to the accumulated radiation will be disregarded in the patients given radium medically when the mesothorium content is not reported. However, the radiation injury from mesothorium, when it is taken into consideration, will be considered equal to the injury from radium per unit dose of radiation delivered.

Microscopic and Roentgenographic Change as a Criterion for MPC

The present MPC of 0.1 microgram is probably already too high if the criterion for the MPC is microscopic change. Characteristic changes in skeletal roentgenographs have been found in connection with a total body radium content of 0.4 microgram. The skeletal roentgenograph is incapable of detecting microscopic changes in the skeleton, and undetected histopathological changes are probably occurring in patients who have a content of 0.1 microgram or less of radium.

Changes in skeletal roentgenographs in patients given radium have been described by numerous investigators (*2, 4–6, 10*). These characteristic, well-differentiated, and widespread changes observed throughout the skeleton are rarely found in any other disease process (*6, 10, 11, 28*). Greater reliance can now be placed on these roentgenographic skeletal changes as a result of studies on the correlation of the frequency of bone involvement with total body radium concentration within a certain dose range (*10, 11*). Thirty of the patients in the Chicago study who were given radium for medical reasons were selected because each of these patients had had a complete roentgenographic examination. They were arranged in order of increasing amounts of retained radium, from 0.5 to 14 micrograms, and the skeletal changes characteristic of the deposition of radioactive materials were tabulated in five bones (*11*). The frequency of involvement was expressed as a percentage of the total number of bones which could possibly be involved. Only 8 percent of the total number of bones were involved in 14 patients who had had between 0.5 and 1 microgram of radium. Fifty-five percent of the bones were involved in seven patients who had had between 1.1 and 2 micrograms of radium, and 65 percent of the bones were involved in nine patients who had had between 2.1 and 14 micrograms of radium.

It is well known that the roentgenograph is not capable of detecting microscopic changes in the skeleton (*29, 30*). Characteristic histopathological changes were found in bone specimens from two patients which were not demonstrated on roentgenographic examination (*11*). This is important for two reasons. First, it demonstrates that the skeletal roentgenograph, the most sensitive clinical device for detecting skeletal changes at present, is inadequate; and second, it suggests that roentgenographic changes which are considered "nondeleterious" (*31*) may represent more extensive skeletal damage than is now appreciated. The small changes in compact bone, detected roentgenographically, are about three to six times the diameter of a Haversian system (*11*). However, high concentrations of radium are usually found in a small percentage of individual Haversian systems (*23–26, 32*). The range of alpha particles in bone is of the order of 25 microns (*23*); therefore, if these skeletal changes are the direct result of alpha radiation coming from radium concentrated in the individual Haversian systems, it would be expected that skeletal changes would be primarily confined to one Haversian system. It is difficult to attribute these macroscopic areas of absence of compact bone to the highly localized alpha radiation within a Haversian system. Radium is also found diffusely distributed throughout bone (*25*); therefore, these changes may be the result either of more generalized damage from the diffusely distributed radium or of more generalized changes such as those which might occur from the effect of radiation on the blood supply.

Serial roentgenographs are available on about ten patients (*11*). Skeletal changes characteristic of radium deposition began to occur about 10 to 15 years after administration of radium. In most of these, a gradual progression of the skeletal change is seen with increasing time after deposition of the radioactive element.

Both microscopic and roentgenographic evidence of radium damage may be expected from less than 0.1 microgram of radium over a normal lifetime from the extrapolation of the results from the patients under observation. For example, the accumulated radiation dose to the skeleton of a patient who received an unknown amount of radium at age 30 and who was found to have 0.5 microgram of radium at age 50 years is of the order of 600 rads during the 20-year period. The total radium content will be about 0.4 microgram at the age of 70 years, and the estimated cumulative radiation dose to the skeleton will be about 950 rads (see Table 1).

Major Skeletal Damage as a Criterion for MPC of Radium

It seems that the importance of major clinical damage has not been fully appreciated in recent considerations of the toxicity of radium. Bone damage occurred as frequently as bone tumors in the 78 patients of the Boston-Chicago investigations (*6, 10, 11*). Seventeen of the 78 patients had major skeletal damage, whereas 15 of the 78 patients developed tumors. Destruction of the head of the femur has also occurred in patients with lower radium content than in radium-treated patients who have had bone tumors (*33*). Ten of the 50 patients given radium, and two of the workers in luminous-dial factories of the Boston-Chicago study had major destructive changes in one or both femoral heads. Four persons who had worked with luminous dials and one radium-treated patient had fractures of the femur (*6, 10, 11*).

The patient with the smallest total body radium content of either the Boston or Chicago series (0.7 microgram) to have major destructive changes was given twelve injections of radium in 1928 and four injections of radium in 1934. In 1950, aseptic necrosis of the right femoral head was found. In 1954, similar destructive changes were found in the other femoral head. The estimated accumulated radiation dose after 22 years was about 1000 rads (Table 1).

In spite of the fact that, as yet, age has not been shown to be a significant factor in major clinical damage, it is possible that major skeletal damage will occur with smaller amounts of radium than has been seen at present as the patients grow older. Some degree of generalized atrophy of bone frequently accompanies the onset of old age (*34*). The rate of calcium accretion also diminishes with age (*35*). Fractures of the femur in the aged are well known (*36*). It is therefore probable that major skeletal damage will occur at, or near, the MPC when the patients under study have had radium deposited in their skeletons over a normal lifetime (*33*). Major skeletal changes may be expected because of the combination of the effects of the increasing accumulated dose, the decreasing ability of the body to repair skeletal damage, and the atrophy of the skeleton in old age in these patients (see Table 1).

Bone Tumors as a Criterion for MPC

Extrapolation of the results of bone tumor induction from radiation beyond 40 years in man is more difficult than projection of either major skeletal damage or roentgenographic changes (*37–39*). Neoplasms were found in 15 of the 78 patients of the recent Boston-Chicago investigations (*6, 10*). Sarcomas of the bone were found in 11 of the 78 patients evaluated. There were seven sarcomas in the 50 patients who received radium and four sarcomas in the 28 who had worked on luminous dials. The patient with the lowest concentration of radium (0.8 microgram) to develop a bone tumor had received radium medically 24 years prior to the occurrence of the neoplasm. The total accumulated radiation dose from mesothorium was estimated to be of the order of 50 rads (*6, 40*). The total accumluated radiation dose from radium was estimated to be about 1100 rads after 24 years (see Table 1).

There is some suggestion that an inverse relationship may exist between radium content and tumor induction when the patients studied by Martland in 1931 are compared with the patients evaluated in 1951 (*2, 11*). There was a latent period for tumor induction of about five to ten years in three patients with contents of 6, 15, and 50 micrograms of radium. There was an average latent period of about 25 years in tumor induction in the eight patients in the Boston-Chicago investigations reported in 1951. The mean radium content in the eight patients was 3.4 micrograms. Little reliance can be placed on estimates of the minimum total body content for tumor induction over a normal lifetime from these meager data.

The available evidence at present suggests that cancer induced by radiation arises from a tissue environment that has suffered severe disorganization, either as a result of local radiation damage, of hormonal disturbance, or of other physiological change arising from radiation exposure (*38*). It may be possible that the neoplasms seen in the radium-treated patients arise from the atypical osseous tissue which is found many years after radioelement deposition (*11, 27*). "More work must be done before it will be possible to discuss with any confidence the mechanism of radiation carcinogenesis" (*38*).

Summary and Conclusions

It cannot be concluded from the present information on the effects of radium in man that the present MPC of 0.1 microgram of radium is permissible. The effects of radium deposited in man in concentrations at or near the present MPC for a period greater than 40 years is not known. Extrapolation of the present results to cover a normal life-time indicates that "appreciable bodily injury" may occur at or below the present MPC. It would seem advisable to consider lowering of the present MPC of radium until information becomes available on the effects of radium in man over a normal lifetime (*41*).

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News of Science

Japan Reports Fusion

Physicists of Osaka University in Japan, directed by Minoru Okada, report that they have obtained a thermonuclear fusion reaction comparable to that announced recently by Great Britain and the United States [*Science* **127**, 275 (7 Feb. 1958)]. A discharge chamber was operated at 85,000 volts and about 1.1 million amperes; a fusion reaction is believed to have occurred for a millionth of a second. It is estimated that the experiment produced temperatures of 1 million degrees Centigrade. Okada told the press that the heat could well have been double that amount and that the experimental equipment should be able to produce 5 million degrees centigrade.

Yasuji Fushimi, chairman of the Atomic Energy Committee of the Japan Academy of Sciences, says that the apparatus used was "much smaller than the British Zeta and cost about one-tenth as much." He observed, however, that the number of neutrons emitted in the Japanese reaction, estimated at 5 million, "seemed to show a better result than Britain's Zeta apparatus." The British experiment produced 3 million neutrons per pulse.

Fushimi also said that Japan's work in thermonuclear fusion was "in the same stage as the Soviet Union was in the tests announced two years ago." In 1956 a Soviet scientist, Igor Kurchatov, told an audience in Britain that temperatures of about 1 million degrees centigrade had been obtained in experiments in which massive electric currents were discharged in short bursts through tubes containing gases such as heavy hydrogen.

National Water Shortage

The Population Reference Bureau warned in a report released on 3 February that "water shortages are now a national problem" and that the United States "might not have enough of this precious mineral to go around" in the not-too-distant future. Although the nation as a whole has increased development and conservation of its water resources in the past 10 years, "our steady population growth is placing heavier and heavier demands on supplies of this most basic natural resource."

The bureau says communities in 45 of the 48 states have been affected by lack of water at one time or another. Furthermore, in 1957, an estimated one in every four Americans felt the water shortage in some manner.

The hardest hit states are those in the Southwest. Paradoxically, this area has received a very large influx of persons from other states in recent years. Projections of the U.S. Census Bureau indicate that five of these states (Nevada, Arizona, California, New Mexico, and Utah) are expected to be among those showing the highest percentage of population increase between 1955 and 1970. Some of these localities may be forced to take steps to restrict the number of new residents, and more especially of new industries. To demonstrate the water shortage in various parts of the nation, the report cites the following cases.

In Dallas, Texas, last year, "water bars" did a lively business selling distilled water at 50 cents a gallon—more than the price of gasoline.

Last fall, the three large reservoirs that serve northeastern New Jersey industry and cities were down to about one-third of normal capacity.

Even in the humid parts of the nation, startling increases in water use have been noted, especially in Indiana and Massachusetts. In southern Indiana, some 100,000 gallons of water a day had to be trucked into rural areas, where farm wells went dry during the record drought in the summer of 1953. Since then, ground-water reserves have improved, but there are considerable areas suffering chronic summer shortages. With an estimated population increase of close to 20 percent for the northeastern United States by 1970, greater expenditures to meet water shortages are predicted there as in large sections of the Midwest. Robert L. Cook, director of the Population Reference Bureau, comments that "there should be vigorous appraisal of some of the economic and social factors behind current fertility trends and migration."

Industrial Engineering Research

The Research Information Committee of the American Institute of Industrial Engineers is starting to secure abstracts of research performed in the period 1 July 1952 to 1 July 1957. Sources from which information will be solicited are universities, industrial organizations, research institutions, and nonprofit organizations, including Government agencies and professional societies. The information-collecting program will provide a valuable service to industry and universities and especially to industrial engineers. Research abstracts are to be collected in the areas of work measurement, methods, plant engineering, human engineering, engineering economics, organization planning, industrial statistics, production control, data processing, operations research, and cost analysis.

The committee will appreciate all information on Industrial Engineering research, past and present, about which it might gather more specific details. Write: Research Information Committee, AIIE, Department of Industrial Engineering, Washington University, St. Louis 5, Mo.

Solar House

A sun-heated house has just been completed in Lexington, Mass., by a team of engineers and architects of Massachusetts Institute of Technology. The result of 20 years of solar energy research at M.I.T., the house has been built to demonstrate that enough facts and equipment are now available to combine a reliably engineered solar heating system with a house designed for comfortable suburban living in a northern climate. The house will be sold to a private family, but M.I.T. engineers will retain separate access to a basement equipment and instrument room to gather data on the performance of the solar heating system after the purchaser has moved in.

The solar collector in the house consists of 640 square feet of glass, two layers thick, over a similar area of thin (.025-inch-thick) aluminum sheet painted a heat-absorbing black. The aluminum sheet absorbs the solar energy, and the glass lets the sunshine in but keeps the longer waves of heat energy from passing back out again.

Water is circulated through copper tubes attached to the aluminum sheet, and the captured solar energy is then transferred from the sheet to the water. This hot water is stored, in turn, in a 1500-gallon basement tank. To heat the house, the hot water in the tank is pumped through a heat exchanger to transfer the heat from the water to a stream of air. This warm air is then forced through ducts and registers to heat the living spaces.

The house uses a small auxiliary oil furnace whenever there is a succession of sunless days. But the present solar system can take care of up to three cloudy days in a row if they have been preceded by a stretch of reasonably mild and sunny weather. The oil burner also insures that hot water for domestic use will be no cooler than 135°F, for the solar system itself can heat the living spaces of the house with water as cool as 95 degrees.

The house was built under the direction of the Space Heating Committee of the Solar Energy Conversion Project, financed by funds contributed by Godfrey L. Cabot. Members of the Space Heating Committee are: Lawrence B. Anderson, chairman of the department of architecture; Albert G. H. Dietz, department of civil engineering; August L. Hesselschwerdt, department of mechanical engineering; Hoyt C. Hottel, department of chemical engineering; and Joseph Kaye, department of mechanical engineering.

Female Mortality

Only the women of Norway have a lower mortality than those of the United States. In Norway the female death rate from all causes is 6.4 per 1000 per year; in the United States the corresponding rate is 6.9 per 1000. The Metropolitan Life Insurance Company provided these figures from a study of 19 countries.

The female death rate from tuberculosis of the respiratory system ranges from a low of 4 per 100,000 in the United States, Australia, and New Zealand, to a high of 47 per 100,000 in Japan. Pneumonia as a cause of death among women also shows a wide variation from the 16 per 100,000 in the United States to the high of 53 per 100,000 in Finland. Only in deaths from motor vehicle accidents do American women suffer the highest rate in the world, 11 per 100,000. The lowest death rate from this cause—2 per 100,000—is found in Israel.

Alexander von Humboldt Centenary

The approaching 100th anniversary of the death of Alexander von Humboldt (1769–1859) has occasioned activities in many lands which focus attention on a great and uniquely influential scientist. Famed for his American travels and diverse contributions to various sciences, Humboldt regarded himself quite justly as "half-American," as is testified by the great esteem in which he was held for half a century by American scientists, statesmen, explorers, and educators. An appraisal of Humboldt's impact on science having been long overdue, the coming centenary is to do justice to his special contributions to plant geography, geology, terrestrial magnetism, and cosmography, and to the generosity of his nature, to which early American science owes a great deal.

The following abstract is meant to give a preliminary picture of various commemorative projects.

In this country the American Philosophical Society, which elected Humboldt a foreign member shortly after his visit in 1804, is sponsoring a documentation of Humboldt which is to assemble autographs and microfilm copies of unpublished letters and related documents. By appointing me library research associate, and aiding me with a grant, the society has received the generous cooperation of domestic and foreign institutions useful for historians of science who are bound to benefit from this task. In addition the society will issue a number of publications which are to include Humboldt's correspondence with T. Jefferson, J. Madison, A. Gallatin, and prominent Americans of a later period (1840–1859).

Another Humboldt tradition in this country is to be honored by the American Academy of Arts and Sciences in Boston, of which Humboldt was made an honorary member at the time of John Quincy Adams. A symposium is being considered to which foreign scholars will also be invited.

In Washington, D.C., I was able to interest the Pan American Union in a memorial meeting to be held under its auspices next year. There also, the Smithsonian Institution may arrange for an exhibition of Humboldt documents.

Other institutions, such as the American Geographical Society and the University of Texas, will contribute to the Humboldt centenary.

A comprehensive collection of Humboldt's letters has long been wanting, especially in Germany, Humboldt's native land, to which he returned following a prolonged residence of 24 years in Paris. Such a project is now under way in East Germany under the auspices of a Humboldt Centenary Committee of the German Academy of Sciences in Berlin, whose members also include scientists from the Federal Republic of Germany and Austria. The editorial and research office is located at Leipzig under the guidance of Adalbert Plott, a Humboldt scholar of long standing. According to information which he most kindly sent me quite recently, several volumes are being prepared. These consist of letters, collected articles, and a complete bibliography. So far 5000 or more items have been assembled.

Humboldt's contributions to Latin American science are being evaluated at the Deutsche Ibero-Amerika Stiftung in Hamburg, a foundation supported by German business interests. Two of its members, A. Meyer-Abich, of the University of Hamburg, and Hans Schneider, traveled all over Latin America in search of Humboldt documents, copies of which are being assembled in the Linga Library of the University of Hamburg, a gift of D. Carlos Linga from Mexico. The Gesellschaft für Erdunde in West Berlin is preparing a memorial volume on Humboldt and will hold a commemorative meeting next year.

One of the leading scientific institutions in the Soviet Union is reported to be planning to honor Humboldt's contributions to Russian science, especially in reference to Humboldt's studies in the Ural Mountains and Central Asia.

Our Latin American neighbors have formed centenary committees, some of which, such as the Venezuelan committee at Caracas, will publish several volumes dealing with Humboldt travels in that country.

HELMUT DE TERRA
Columbia University, New York

Grants, Fellowships, and Awards

Advanced basic research and teaching. The University of Wisconsin will receive $100,000 a year for 5 years from the Wisconsin Alumni Research Foundation to support a 5-year postdoctoral fellowship program in basic research related to national defense. The grant will provide about 15 fellowships annually for outstanding young scientists to prepare for careers in advanced basic research teaching. Each fellowship will carry a maximum stipend of $6000 for the academic year or $7200 on a 12-month basis. The selection of recipients has begun. The University Research Committee reports that "any individual who recently has received his doctor's degree and has demonstrated his ability and interest in basic research related to the natural sciences will be considered for these awards."

Natural Sciences. The Weizmann Institute of Science, Rehovoth, Israel, has announced two Chaim Weizmann Memorial Fellowships in the natural sciences for the academic year 1958–59. These annual fellowships are intended for young scientists with several years of postdoctoral research experience. It is expected that the candidate will have worked in a field close enough to one of the subjects under investigation at the Weizmann Institute to be able to join an existing research team. The stipend, including fare, ranges from $3500 for a single fellow to $5500 for a married scientist with family. Payment is made in dollars. The institute endeavors to help find suitable accommodation. Applications should reach the Academic Secretary, Weizmann Institute of Science, Rehovoth, Israel, *not later than 10 April.*

Oceanography and Tuna Expedition

The University of California's Scripps Institution of Oceanography has announced that the Scripps Tuna Oceanography Research Group and the Inter-American Tropical Tuna Commission will carry out an expedition to the Eastern Tropical Pacific during the period 28 April through approximately 7 July. It will be known as the SCOT (Scripps Cooperative Oceanography and Tuna) Expedition. The research vessel *Spencer F. Baird* will be used. Support for the Scripps portion of the expedition will come from the U.S. Fish and Wildlife Service through the existing tuna oceanography contract.

The participating bodies are both concerned with scientific studies on the relationships of eastern tropical Pacific tuna populations to their environments, although for different reasons: the general purpose of the Scripps group is to forecast availability of fishable schools, whereas that of the Tuna Commission is to secure the rational exploitation of the tuna resource as a whole. These studies now require a survey cruise in the spring and early summer; most of the past work has been done at other seasons of the year. R. W. Holmes of Scripps will be executive leader of the first and major part of the expedition.

AAAS Socio-Psychological Prize

Through the generosity of an anonymous donor, the AAAS offers an annual prize of $1000 for a meritorious essay in socio-psychological inquiry. Previous winners of this prize and the titles of their essays have been: Arnold M. Rose, "A theory of social organization and disorganization"; Yehudi A. Cohen, "Food and its vicissitudes: a cross-cultural study of sharing and non-sharing in sixty folk societies"; Herbert C. Kelman, "Compliance, identification, and internalization: a theoretical and experimental approach to the study of social influence"; and Irving A. Taylor, "Similarities in the structure of extreme social attitudes."

The conditions of competition for the prize to be awarded at the 1958 annual meeting, Washington, D.C., 26–31 December, are as follows.

1) The contribution should further the comprehension of the psychological-social-cultural behavior of human beings—the relationships of these hyphenated words being an essential part of the inquiry. Whether the contributor considers himself to be an anthropologist, a psychologist, a sociologist, or a member of some other group is unimportant as long as his essay deals with basic observation and construction in the area variously known as social process, group behavior, or interpersonal behavior. For ease of reference in the rest of this statement, this general area will be called "social behavior."

2) The prize is offered to encourage studies and analyses of social behavior based on explicitly stated assumptions or postulates, which lead to experimentally verifiable conclusions or deductions. In other words, it is a prize intended to encourage in social inquiry the development and application of dependable methodology analogous to the methods that have proved so fruitful in the natural sciences. This is not to state that the methods of any of the natural sciences are to be transferred without change to the study of social behavior, but rather that the development of a science of social behavior is fostered through observation guided by explicit postulates, which in turn are firmly grounded on prior observations. It may be taken for granted that such postulates will include a spatial-temporal framework for the inquiry. It may properly be added that the essay should foster liberation from philosophic-academic conventions and from dogmatic boundaries between different disciplines.

3) Hitherto unpublished manuscripts are eligible, as are manuscripts that have been published since 1 January 1957. Entries may be of any length, but each should present a completed analysis of a problem, the relevant data, and an interpretation of the data in terms of the postulates with which the study began. Preference will be given to manuscripts not over 50,000 words in length. Entries may be submitted by the author himself or by another person on his behalf.

4) Entries will be judged by a committee of three persons considered well qualified to judge material in this field. The judges will be selected by a management committee consisting of the chairman and the secretary of Section K and the executive officer of the AAAS. The committee of judges reserves the right to withhold the prize if no worthy essay is submitted.

5) Entries should be sent to Dael Wolfle, Executive Officer, American Association for the Advancement of Science, 1515 Massachusetts Ave., N.W., Washington 5, D.C. Entries should be submitted in quadruplicate. Each entry should be accompanied by six copies of an abstract not to exceed 1200 words in length. The name of the author should not appear anywhere on the entry itself but should be enclosed on a separate sheet of paper which also gives the author's address and the title of his essay. Entrants who wish to have their manuscripts returned should include a note to that effect and the necessary postage. To be eligible for consideration for the prize that will be awarded at the 1958 annual meeting of the Association, entries must be received *not later than 1 September 1958.*

Radiation Committee

The establishment of a National Advisory Committee on Radiation has been announced by the Public Health Service. The committee will advise Surgeon General Leroy E. Burney on the further development of programs dealing with public health aspects of radiation. The President's budget for the Department of Health, Education, and Welfare for the next fiscal year requests $608,000 for the Public Health Service's radiological health activities, a 50-percent increase over funds available during the current year.

Last August, the surgeon general appointed Russell H. Morgan, professor of radiology at Johns Hopkins University Medical School, as special consultant on the public health aspects of radiation. Morgan will serve as chairman of the new committee, which will hold its initial meeting on 13 March. Those appointed to the committee are: Arnold O. Beckman, Beckman Instruments, Inc.; Victor P. Bond, Brookhaven National Laboratory; Richard H. Chamberlain, University of Pennsylvania; James F. Crow, University of Wisconsin; Herman E. Hilleboe, New York Commissioner of Health; Edward B. Lewis, California Institute of Technology; Berwyn F. Mattison, American Public Health Association; Lauriston S. Taylor, National Bureau of Standards; George W. Thorn, Peter Bent Brigham Hospital; and Abel Wolman, Johns Hopkins University.

Religion and Science

On the six Sundays from 2 March to 6 April the Community Church, New York, has scheduled a series of discussions on *Religion in an Age of Science.* The program includes: Harlow Shapley, Paine professor of practical astronomy, emeritus, Harvard University, "God, Man, and the Vast Drama of Creation"; Loren Eiseley, chairman of the department of anthropology, University of Pennsylvania, "The Evolution of the Spirit"; Abraham N. Franzblau, professor of pastoral psychology and dean of the Schools of Education and Sacred Music, Hebrew Union College, "The

Psychology of Salvation"; Arthur E. Morgan, president of Community Service, Inc., first chairman of the Tennessee Valley Authority, and former president of Antioch College, "The Sociology of Survival"; Brand Blanshard, Sterling professor of philosophy, Yale University, "The Appeal to Reason in Science and Religion"; and J. B. Rhine, director of the Parapsychology Laboratory, Duke University, "Science and the Spiritual Nature of Man."

Experimental Breeder Reactor

The Argonne National Laboratory has been authorized by the Atomic Energy Commission to proceed with the construction of a large experimental breeder reactor at the AEC's National Reactor Testing Station near Idaho Falls, Idaho. A sum of $29.1 million has been authorized for the design and construction of this facility. The reactor is to be known as Experimental Breeder Reactor No. 2 (EBR-2). It was developed as a successor to the Experimental Breeder Reactor No. 1 (EBR-1), which was placed in operation at the Idaho Falls site in 1951.

Power engineers regard the breeder-type reactor as economically promising because it produces more fissionable material than is burned in the reactor. This reactor, therefore, provides the possibility of using economically and efficiently all natural uranium rather than only the uranium-235 as in some other reactor types.

The EBR-2 is an integral nuclear power plant. It includes a complete fuel processing and fabrication facility in addition to the reactor, heat transfer systems, and steam-electric plant. The thermal power rating of the reactor is 62,500 kilowatts. Net electrical power output is rated at 17,500 kilowatts. Operation is scheduled for 1960. Argonne will also build the Argonne Boiling Reactor (ARBOR) and the Transient Reactor Test Experiment (TREAT) at the Idaho site.

Soviet and East European Publications

The names of two Library of Congress monthly publications, which serve as keys to new literature coming into this country from the U.S.S.R. and eastern Europe, have been changed from "Lists" to "Indexes." The purpose of the change is to indicate to scientists and other scholars not familiar with the monthlies that they are more than mere booklists and that they contain information about the content of new Russian and East European books and articles. The *Monthly List of Russian Accessions,* which enters its 11th year of publication in April 1958, becomes the *Monthly Index of Russian Accessions.* The Government Printing Office sells it for $12 a year ($15 abroad). The *East European Accessions List,* published since 1951, becomes the *East European Accessions Index.* The GPO sells it for $10 a year ($12.50 abroad).

Each index gives in English a monthly account of new material in a variety of subject fields as received from the U.S.S.R. and eastern Europe by the Library of Congress and by other American research libraries. The translation of all titles of books and articles into English and the elaborate subject guides in English permit a researcher who has no command of Russian or East European languages to identify easily the material important to him.

The indexes are of particular value to the scientist. For example, 54 percent of the books and periodicals reported in volume 9 (April 1956–March 1957) of the *Monthly Index of Russian Accessions* were in the field of science and technology.

News Briefs

The U.S. House of Representatives has voted unanimously to set up a special committee to consider legislation relating to space exploration. House Democratic Leader John W. McCormack (Mass.) is chairman and House Republican Leader Joseph W. Martin, Jr. (Mass.), is ranking minority member. The 13-man committee is patterned after a similar Senate group created last month [*Science* **127**, 392 (21 Feb. 1958)]. The first question confronting both groups is whether space programs should be under military or civilian control.

* * *

The cost of tuberculosis in the United States increased by $100 million between 1952 and 1956, bringing the total cost in 1956 to more than $725 million. This is revealed in a study made by the U.S. Public Health Service. The estimate, based on data from both governmental agencies and nongovernmental organizations, are published as a note in the January issue of the *American Review of Tuberculosis and Pulmonary Diseases,* publication of the National Tuberculosis Association. The authors are Edward T. Blomquist, chief of the Tuberculosis Program, PHS, and Blanche H. Barbour, statistician with the program.

* * *

The 23rd *Semiannual Report of the Atomic Energy Commission* has been released. The first 76 pages of this 464-page paper-bound volume comprise a 3-year summary of progress. The report, dated January 1958, may be obtained from the Government Printing Office, Washington 25, D.C.

* * *

About 8 million persons in the United States attend at least one formal adult-education class each year, the U.S. Office of Education reports. This was learned in a national survey—conducted by the Bureau of the Census and financed by a $10,000 grant from the Fund for Adult Education to the Adult Education Association, U.S.A.

* * *

In connection with a review by the Atomic Energy Commission of its program relating to patents in the atomic energy field, the commission will hold a public meeting to give interested persons opportunity to be heard. The meeting will be held in Washington on 15 April in Room 1067, 1717 H St., N.W., beginning at 10:00 A.M.

* * *

Louis Armand, president of EURATOM, has accepted an invitation to visit Washington in April. The invitation of Secretary of State Dulles and Chairman of the Atomic Energy Commission Lewis L. Strauss proposes a discussion of the possibilities of close cooperation between the United States Government and the European Atomic Energy Commission in the fields in which EURATOM will be engaged in order to develop the peaceful uses of atomic energy. To prepare the visit, the EURATOM Commission and the United States Government have set up a joint working party.

* * *

More than 80 investigators from nine countries, including eight from the Soviet Union, recently participated in the first international conference aimed at improving methods of predicting the formation of ice in the Arctic Ocean and neighboring seas. The conference, held at the Tidewater Inn, Easton, Md., was organized by the Division of Earth Sciences of the National Academy of Sciences–National Research Council. It has been estimated that accurate observation of the nature and extent of sea ice could result in the saving of many millions of dollars to United States vessels alone in the arctic and subarctic regions.

* * *

The Cancer Chemotherapy National Service Center is seeking reprints for a reference collection covering the broadest range of endocrine-cancer relationships, as well as basic endocrinology. In particular it needs clinical data on cancer patients treated with hormones, data on the biological activities of hormones, analogs, and antagonistic substances, and data on the effects of hormones on animal tumors. Assay data on steroids would be especially welcome. Those wishing to assist should send reprints to: Dr. D. Jane Taylor, Endocrinology Section, Cancer Chemotherapy National Service Center, National Institutes of Health, Bethesda 14, Md.

* * *

Formation of the National Foundation for Research in Ulcerative Colitis, with headquarters in Washington, D.C., was announced at a recent conference in Washington on "New Frontiers in Ulcerative Colitis." The meeting was sponsored by the General Medicine Study Section of the National Institutes of Health and supported by a research grant from the foundation and the National Institute of Arthritis and Metabolic Diseases.

* * *

Atomic Energy of Canada Limited reports that the NRU reactor at Chalk River, Ontario, is the first reactor to be refueled while in operation. All other reactors have to be shut down before they can be refueled. This causes interruption of experiments and isotope production in the case of research reactors and the stoppage of electricity generation in the case of power reactors. Chalk River's new 43-foot-high, 240-ton refueling machine was used successfully on 22 February.

* * *

Among the award winners announced at the recent Thomas Alva Edison Foundation Children's Book and Comic Book Awards luncheon at the Waldorf-Astoria, New York, were the following: best children's science book, *The Wonderful World of Energy,* written by Lancelot Hogben and published by Garden City Books; best science book for youth, *Building Blocks of the Universe,* written by Isaac Asimov and published by Abelard-Schuman; and best science comic book, *Walt Disney's Mars and Beyond,* published by the Dell Publishing Company.

* * *

The Atomic Energy Commission has announced that the United States will participate in the fifth International Electronic and Nuclear Energy Exposition and Congress in Rome, Italy, 16–30 June. The AEC is preparing an exhibit entitled "Atoms to Serve Mankind." In addition, a delegation of scientists and engineers from the commission and its contractors will present papers on atomic energy and its uses. John Vinciguerra, assistant manager of the AEC's Savannah River Operations Office, has been appointed project manager for the exhibit.

* * *

Discovery of a new bactericidal gas by a team of Chemical Corps scientists was announced recently by C. R. Phillips, chief of physical defense division, U.S. Army Chemical Corps, Fort Detrick, Md. The new gas is beta-propiolactone, a compound which had been used previously for sterilization only in aqueous solution. As a gas it acts as effectively as formaldehyde vapor but works more rapidly and with fewer adverse side effects. Phillips predicts that a few years' study will prove that the gas has "important applications" with possible use "in sterilizing operation rooms, nurseries within hospitals, and the like."

* * *

A new research rocket developed as a private venture by Aerojet-General Corporation, the "Aerobee 100," was furnished to the Naval Research Laboratory for its first flight evaluation at the U.S. Naval Ordnance Missiles Flight Test Facilities at White Sands Proving Grounds, N.M., on 18 February. The test was a complete success, with the rocket reaching an altitude of 60 miles and successfully completing its flight mission.

* * *

The Proceedings of the Tenth International Congress of Entomology, held in Montreal, Canada, in August 1956, are expected to be ready for distribution in late 1958. The price is $75, postpaid, for the set of four volumes. Since a limited number will be printed, only orders received *before 1 May* can be guaranteed. For further information write to: Tenth International Congress of Entomology, Science Service Building, Ottawa, Canada.

Scientists in the News

Six American women medical scientists will leave during the second week in May for a 1-month tour of medical institutions in the U.S.S.R. Preliminary arrangements for the trip have been completed by the National Academy of Sciences in cooperation with the Rockefeller Foundation, the American Medical Association, and the American Medical Women's Association. The itinerary within the Soviet Union will be planned by Soviet authorities to accommodate the visitors' special scientific interests.

The visit is the result of an exchange agreement. Last October six women scientists from the U.S.S.R. spent a month in the United States visiting medical institutions in six cities in the East and Middle West.

The delegation will be headed by HELEN B. TAUSSIG of Johns Hopkins University Hospital, a pediatrician who has won international recognition for her contributions to the treatment of cardiac diseases in children. Other members of the delegation are: LEONA BAUMGARTNER, commissioner of health, New York City, national leader in public health; THELMA B. DUNN, National Institutes of Health, Bethesda, Md., an investigator of the pathology of cancer; JEAN HENLEY of Columbia University College of Physicians and Surgeons and head of the department of anesthesiology, Francis Delafield Hospital; ESTHER C. MARTING, radiologist, University of Cincinnati School of Medicine, Cincinnati, Ohio, and past president of the American Medical Women's Association; and MARGARET H. SLOAN of the National Academy of Sciences–National Research Council, who is in charge of the Academy–Research Council's advisory services to the National Blood Program.

The National Foundation for Infantile Paralysis recently dedicated a poliomyelitis Hall of Fame. Among those whose busts were unveiled in a quadrangle of the Warm Springs Foundation, Warm Springs, Ga., were four deceased scientists: JACOB von HEINE of Stuttgart, Germany, who first described poliomyelitis clearly in 1840; OSKAR MEDIN of Stockholm, Sweden, who in 1907 first recognized the disease as an acute infection; IVER WICKMAN, also of Sweden, a pioneer in 1909 in studying poliomyelitis as an epidemic disease; and KARL LANDSTEINER of Vienna, who demonstrated in 1909 that poliomyelitis could be transmitted to an experimental animal.

The 11 living scientists who were honored included: JONAS SALK, who developed poliomyelitis vaccine; THOMAS M. RIVERS, medical director of the National Foundation and chairman of the committee that supervised the successful 1954 field trials of Salk vaccine; CHARLES ARMSTRONG, retired research worker of the U.S. Public Health Service who in 1939 discovered that certain strains of poliovirus could be transmitted to cotton rats; JOHN R. PAUL, Yale University virologist who contributed significantly to knowledge of the disease; ALBERT B. SABIN of Cincinnati University, leader in the search for a live virus vaccine; THOMAS FRANCIS, Jr., University of Michigan epidemiologist who directed the 1954–55 evaluation program demonstrating the safety and effectiveness of Salk vaccine; JOSEPH L. MELNICK of the National Institutes of Health, who as a Yale University research scientist studied poliomyelitis incidence and immunity in many parts of the world; ISABEL MORGAN of Columbia University, who at Johns Hopkins University prepared an experimental vaccine from virus inactivated with formaldehyde and with it protected monkeys against paralytic poliomyelitis; HOWARD H. HOWE of Johns Hopkins University, first to show that chimpanzees could acquire poliomyelitis infection by mouth; DAVID BODIAN of Johns Hopkins University, who proved that poliomyelitis could be blocked by antibodies in the blood before it reached the central nervous system; JOHN F. ENDERS of the Children's Medical Center, Boston, who won the Nobel Prize for discovering a method for growing poliovirus in non-nervous tissue.

DALE E. OYSTER, formerly deputy for requirements, Headquarters United States Air Force, has joined the staff of the Rand Corporation, Santa Monica, Calif., as assistant to the chief of the engineering division.

GIULIO NATTA, professor in the Polytechnic Institute of Milan, Italy, has been elected a fellow of the New York Academy of Sciences in recognition of his discoveries in polymer chemistry. He has developed a process for the first commercial production of a new type of polypropylene plastics. The academy will install professor Natta when he visits this country in April to speak before the American Chemical Society's national meeting in San Francisco, Calif.

GLEN A. RICHARDSON, who joined the engineering faculty of the Worcester Polytechnic Institute the first of the year, will become head of the department on 1 July. Previously he was associate professor of electrical engineering at Iowa State College. Richardson succeeds THEODORE H. MORGAN, department head since 1931, who will continue in his post as professor of electrical engineering.

The six members of the new Board of Scientific Counselors of the National Institute of Neurological Diseases and Blindness include: RAYMOND D. ADAMS, chief of neurological services at the Massachusetts General Hospital, Boston, Mass.; HOWARD J. CURTIS, chairman, Biological Division, Brookhaven National Laboratory, Upton, N.Y.; A. EARL WALKER, professor of neurosurgery, Johns Hopkins University; ROGER J. ROSSITER, head of the department of biochemistry, University of Western Ontario, London, Canada; ALGERNON B. REESE, clinical professor of ophthalmology, College of Physicians and Surgeons, Columbia University; and HALLOWELL DAVIS, director of research at the Central Institute for the Deaf, St. Louis, Mo., chairman.

HANS WAINE has been named associate professor of medicine at the Tufts University School of Medicine. He holds appointments as medical director, New England Arthritis and Rheumatism Foundation and as chief of staff, Boston Dispensary, Boston, Mass.

Borden awards of a gold medal and $1000 have been presented to one Canadian and seven American scientists for their outstanding research achievements during 1957. The awards are administered by professional and scientific associations. The 1957 winners are: STUART PATTON, associate professor of dairy science, Pennsylvania State University, the American Chemical Society award for research in the chemistry of flavor compounds in milk and dairy products; J. THOMAS REID, professor of animal husbandry, Cornell University, the American Dairy Science Association award for numerous researches relating to dairy cattle nutrition; N. P. TARASSUK, professor of dairy industry and dairy chemist, University of California, the American Dairy Science Association award for studies that have established the multiplicity of the lipase systems in milk; MARY L. DODDS, professor of foods and nutrition, Pennsylvania State University, the American Home Economics Association award for research contributions in the field of nutrition and experimental foods; MURRAY L. BARR, professor and head of the department of microscopic anatomy, University of Western Ontario, the Association of American Medical Colleges award for research in neurohistology and cytology, and for the discovery of the "sex chromatin"; ARIL E. HANSEN, professor and chairman of the department of pediatrics, University of Texas Medical Branch, the American Academy of Pediatrics award for research on the role of essential fatty acids in the infant's diet; B. R. BURMESTER, senior biologist, U.S. Regional Poultry Research Laboratory, East Lansing, Michigan, the Poultry Science Association award for work on avian lymphomatosis; S. H. McNUTT, professor of veterinary science, University of Wisconsin, the American Veterinary Medical Association award for research in dairy cattle disease control, with particular reference to brucellosis.

In the past year the Kaiser Foundation, Oakland, Calif., has formally established as its Laboratory of Comparative Physiology and Morphology a research group that it had supported informally for some years as a guest entity on the Berkeley campus of the University of California. The laboratory, which will be established in permanent quarters outside the university within the next year, has a program of research in fundamental biology, especially in the comparative nutrition of lower Metazoa and comparative biochemistry of Protista. The senior research staff consists of: ELLSWORTH C. DOUGHERTY, director; MARY BELLE ALLEN, associate director; BENJAMIN G. CHITWOOD, research scientist; EDER LINDSAY HANSEN, associate research scientist; and WARWICK L. NICHOLAS, visiting associate research scientist (on leave from the University of Liverpool, England). Several University of California staff members serve in a consultant capacity.

R. OMAR RILETT, associate professor of biology, has resumed his duties at the University of Buffalo after visiting the Department of Industrial and Scientific Research in Slough, England, where he was investigating the biology of insects that attack stored products. While overseas, he was elected a fellow of the Royal Entomological Society.

FERDINAND E. OKADA, cultural anthropologist and teacher with the department of public instruction at the American Museum of Natural History, New York, has left for a year's research in Nepal, where he will conduct investigations in the general area of social organization among some of ten or twelve former tribes.

TORBJOERN CASPERSSON, professor of medical cell research and genetics and director of the Nobel Institute's Institute for Cell Research, Stockholm, Sweden, delivered the 22nd Adam M. Miller Lecture at the State University of New York Downstate Medical Center on 5 March. He spoke on "Cytochemical Techniques for Tumor Cell Population Studies."

Recent Deaths

DANIEL BLOCK, Bronx, N.Y.; 32; assistant professor of mathematics at Yeshiva University; 28 Feb.

EILHARD VON DOMARUS, New York, N.Y.; 64; supervising psychiatrist at the Postgraduate Center for Psychotherapy, New York; author of *Language and Thought in Schizophrenia*; 25 Feb.

LEROY A. HALBERT, Chevy Chase, Md.; 82; pioneer social worker; author of *Urban Society*, used as a text in many colleges, and *What is Professional Social Work?;* Congregationalist minister; 3 Mar.

ANDRE L. JORISSEN, Ithaca, N.Y.; 45; head of the hydraulics and hydraulic engineering department at Cornell University; 28 Feb.

JAMES R. WEBSTER, Chicago, Ill.; 51; president of the Academy of Dermatology and professor of dermatology at the Northwestern University Medical School; 28 Feb.

IRA WILLIAMS, Delray, Fla.; 77; before he retired in 1946, a mathematics master at the Lawrenceville (N.J.) School for 28 years; 3 Mar.

Book Reviews

The Economics of Communist Eastern Europe. Nicholas Spulber. Technology Press of Massachusetts Institute of Technology and Wiley, New York; Chapman & Hall, London, 1957. xxviii + 525 pp. Illus. $12.50.

This bulky volume by Nicholas Spulber, associate professor of economics at Indiana University, is a well-documented and well-rounded account of the economic evolution of communist Eastern Europe since World War II. The countries discussed are Czechoslovakia, Poland, Hungary, Romania, Bulgaria, and Yugoslavia. Albania and Eastern Germany are not included because, according to the author, their economic development since 1945 conformed to a pattern different from that of the other six countries. The preliminary draft of the study was completed in the years 1952–54 when Spulber was associated with the Center for International Studies of Massachusetts Institute of Technology, but the manuscript was revised and brought up to date through 1955, 1956, and the beginning of 1957.

Spulber depends chiefly on statistical data from Eastern European sources. He has no illusion about their comprehensiveness and reliability, but he believes that, if used with circumspection, they provide an adequate ground for valid generalizations. In his Foreword M. F. Millikan sounds a note of caution by stating that "the reader will have to make his own judgment" about the merit of the data presented and of the conclusions based on them.

With this reservation, Spulber has written a useful book. He is thoroughly familiar with his subject and seems at ease amid the baffling complexities of the Balkan situation. His introductory section on the historical background is very well done and contains some revealing observations—for instance, the discussion of the prevalence of state ownership before the war. The bulk of the study deals, with a varying degree of thoroughness, with nationalization, planning, and the nature of the relationship between the European satellites and the Soviet Union. Spulber throws some interesting light on such relatively little known issues as the nature and effects of the reparations exacted by Moscow from the former Eastern European enemies, the establishment and the dismantling of the joint companies, and the activities of the Council of Economic Mutual Assistance.

The 17 maps and charts and the 138 statistical tables, some of them very detailed ones, are presumably responsible for the prohibitive price of the book. This may be another reason why greater restraint and selectivity in using statistics would have been justified.

MICHAEL T. FLORINSKY
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Tranquilizing Drugs. A symposium held under the auspices of the American Association for the Advancement of Science in cooperation with the American Psychiatric Association and the American Physiological Society and presented at the Atlanta, Georgia, meeting, December 27–28, 1955. AAAS Publication No. 46. Harold E. Himwich, Ed. American Association for the Advancement of Science, Washington, D.C., 1957. Members, $4.50; others, $5.

Ralph W. Gerard, in a recent article in *Science,* has suggested facetiously that symposia on psychopharmacology may be becoming a drug on the market. Although it is true that the proceedings of a considerable number of meetings dealing with the newer psychiatric drugs have appeared in the last three years, I believe these fill a real need.

The great interest stimulated by the discovery of chemical substances able to alter the symptomatology and behavior of psychiatric patients or the psychological functioning of normal subjects has resulted in an increasing amount of research activity. Symposia held by scientific organizations have enabled investigators to present their own recent findings and to learn of the work and thoughts of others. In rapidly expanding fields such as this, their publication supplements in a useful manner the publication of individual articles in the existing journals and often makes available, within a single volume, types of articles which would never appear in the same journal because of the limited scope and limited space of many periodicals.

The volume entitled *Tranquilizing Drugs,* edited by Harold E. Himwich, is the result of such a symposium, which was held in Atlanta, Georgia, in December 1955, under the auspices of the American Association for the Advancement of Science in cooperation with the American Psychiatric Association and the American Physiological Society. The meeting itself was well attended and of great interest, and publication of its proceedings makes generally available an outstanding collection of papers in this expanding field.

The material presented is worthy of special note for a number of reasons. This is the first of such symposia to include such a varied group of basic studies. These range from work on the cerebral synaptic actions of drugs by Marrazzi and Hart, through studies of electroshock latency by Toman *et al.* and depth electrode work as reported by Hendley, Lynes, and Berger, to studies of the alerting response by Himwich and Rinaldi. These articles describe the effects of a number of different drugs on the systems under consideration and thereby provide a particularly interesting overview both of techniques used and of findings obtained in basic studies of electrophysiological properties by means of drugs.

The presence of reports by Grenell of the striking effects of chlorpromazine on brain adenosine triphosphate and by Hoffer of a well-controlled study of the psychological effects of adrenolutin on normal subjects serves to underline the breadth and general interest of this publication.

At the clinical level, the number of drugs reported upon and the various levels of approach and types of patients studied again emphasize the considerable scope of the volume. Work on patients seen in intensive psychotherapy is included, as are controlled studies on chronic schizophrenics. Detailed reports of specific research projects are included, as are competent general articles by experienced clinicians on the usefulness or the side effects of these compounds. The drugs studied include azacyclonol, meprobamate, chlorpromazine, reserpine, rescinnamine, canescine, and combinations of reserpine and chlorpromazine. In addition, iproniazid, a drug of considerable recent interest, was used in one study. Although the conclusions arrived at in some of these investigations may be open to qualification or modification as a result of other more recent work, the papers as a whole remain interesting and informative. All in all, Himwich is to be commended for bringing together a group of papers outstanding in their variety, which present an excellent picture of the field of psychopharmacology at the time the symposium took place.

JONATHAN O. COLE

Psychopharmacology Service Center,
National Institute of Mental Health,
National Institutes of Health

Biochemistry and Human Metabolism. Burnham S. Walker, William C. Boyd, and Isaac Asimov. Williams and Wilkins, Baltimore, Md., ed. 3, 1957. vii + 896 pp. $12.

The third edition of this excellent textbook of human biochemistry incorporates expanded treatment of such topics as the high-energy acyl-mercaptan bond in metabolism, the abnormal hemoglobins, the sodium pump theory of membrane potentials, and the carbon cycle in photosynthesis. The "Tissue chemistry" and "Enzymes" chapters of earlier editions have been subdivided into four chapters, entitled "Carbohydrates and lipids," "Tissue chemistry," "Enzymes and coenzymes," and "Enzyme systems." This last chapter includes a section on thermodynamics.

This edition retains the unique arrangement of subject matter and the excellent chapter on reproduction and heredity of the first and second editions.

CARLETON R. TREADWELL

George Washington University

From the Closed World to the Infinite Universe. Alexandre Koyré. Johns Hopkins Press, Baltimore, Md., 1957. xii + 313 pp. Illus. + plate. $5.

Few episodes in the evolution of scientific ideas have been so neglected by historians as the 17th century's infinite expansion of the Aristotelian and early Copernican cosmos. The reasons for the neglect are clear. Since the 17th century produced no evidence for the infinite universe, men like Descartes and Newton could have abandoned the finite cosmos of Copernicus and Kepler only on speculative philosophical grounds. The historian of science has, however, normally spurned speculative philosophy while his colleague in philosophy has shied from the nonmethodological parts of science. As a result, the 17th-century transition "From the Closed World to the Infinite Universe" has, until this recent study by Alexandre Koyré, fallen between two institutionalized areas of scholarship.

Koyré's essay, particularly if it is taken in conjunction with his earlier fundamental contributions to the immediate prehistory of Newtonian dynamics, demonstrates how unfortunate the almost standard neglect of the borderlines between science and philosophy has been. Whether speculative or not, creative concern with the physically infinite proves to have been one of the universally creative elements in 17th-century thought. In his *Etudes Galiléennes,* Koyré graphically described its fruitful impact upon the formulation of physical problems, emphasizing, for example, its role in the transformation of Galileo's limited principle of inertia into the now familiar Cartesian-Newtonian form. In the present study he turns to the infinite universe itself, discussing first its 16th-century roots and then its effects upon the development of 17th-century philosophy and theology. The subject directs Koyré to many of the period's most fascinating figures. In his first four chapters Nicholas of Cusa, Palingenius, Copernicus, Digges, Bruno, Gilbert, Kepler, Galileo, and Descartes debate the finitude of the universe. In the remaining eight, Henry More, Malebranche, Newton, Bentley, Raphson, Berkeley, Clarke, and Leibnitz discuss the implications of physical infinity for the conceptions of space, force, and Deity and for other concepts besides.

Since Koyré's expository technique is *explication des textes* (perhaps a third of his volume is quotations), the penetrating perceptions that are his own characteristic contribution defy summarization. One of them must serve as example for the whole. In both the Aristotelian and early Copernican cosmos, God's throne had been beyond the outermost sphere. In the infinite universe of Descartes and Newton, there could be no such location; therefore, only an immanent Deity could preserve continuing contact with his creation. As a result, one persistent tendency of 17th-century thought was the identification of God with space or with space-filling fluid. During the century, the previously mystical and incommunicable vision of a Neoplatonic *anima mundi* increasingly became a necessity of rational natural theology.

Readers of Koyré's book can find for themselves many other analyses of equal interest. They may question a few of these. (Should any treatment of the transition to an infinite universe pay so little attention to the revival of atomism? Did Newton reject mechanism so explicitly or unequivocally as Koyré believes?) But these questions will concern details, minor in a volume that makes a new area of study accessible to a new group of readers. The word *accessible,* however, raises a more important problem, about which a word of warning may be in order. The lucid colloquial style which makes this book so pleasant to read often combines with the intrinsic limitations of exposition through quotation and commentary to disguise both the coherence and the significance of the topics treated. Koyré has provided the material and has illuminated it with uniformly perceptive and occasionally brilliant commentary. Yet both material and commentary sometimes seem too little controlled. It will take careful readers or ones with more than average background to isolate and follow the conceptual threads that make this volume an important contribution to the study of 17th-century thought.

THOMAS S. KUHN

University of California, Berkeley

The Chemistry of Plants. Erston V. Miller, Reinhold, New York; Chapman & Hall, London, 1957. vii + 174 pp. Illus. $4.75.

There are many ways of organizing a discussion of the chemistry of plants. Erston Miller has chosen a classical and straightforward approach. Twelve successive chapters consider, successively, carbohydrates, proteins and other nitrogen compounds, lipides, plant pigments, enzymes, organic acids, plant hormones, glycosides, alkaloids, vitamins, the inorganic elements, and other miscellaneous plant products such as ethylene and various growth inhibitors. The discussion is an elementary one. Thus, chapter I on carbohydrates gives the reader a little elementary carbohydrate chemistry, a small catalog of the various carbohydrates which are found in plants, and a little physiology. This pattern is followed throughout the book, which then, as a whole, is long on classification of substances and on lists of occurrences of substances and very short on metabolism, on structure, on any feeling for the way in which chemical compounds are put together to make a living plant. In part, this is due to Miller's avowed intention to make his book a chemistry book and not a volume on plant physiology. But the attempt is not a wholly successful one. The phenomenology of the occurrence of compounds in plants is all very well, but there are so many compounds present in a plant that it leaves the reader bewildered. Coherence and clarity would have been contributed to the volume by more detailed consideration of the way in which compounds are biochemically related to one another, more detailed discussion of metabolic pathways, and more detailed discussion of the role of each material in the overall chemistry of the life process.

Although this book appears in 1957, much of the material in it is already outdated. There is, for example, no indication of the extent of our knowledge of the mechanism of nitrate reduction and no indication of the source of the reducing power which drives this important plant process. Neither is there any consideration of our extensive information on the biosynthesis of glutamine and asparagine—those two classical plant amides. The formation of fatty acids, the synthesis of peptide bonds, the biogenesis of alkaloids—these are all matters which could well be treated in a more modern way and would, if so treated, convey more understanding to the reader.

This little book (163 pages of text) may serve as an introduction to plant composition on the undergraduate level. It won't, however, be very informative to either the chemist or the plant scientist—that is, to the professional worker in the field.

James Bonner
California Institute of Technology

Mathematics and Wave Mechanics. R. H. Atkin. Wiley, New York, 1957. xv + 348 pp. Illus. $6.

The most striking characteristic of this book is the wide range of topics covered. The first 130 pages deal with mathematical topics—from the laws of elementary algebra to Hilbert space and from the most elementary ideas of analysis to fairly extended discussions of special functions. Seventy pages are then devoted to classical mechanics and electromagnetic theory, plus supporting mathematical theorems. Finally, 145 pages are given over to a survey of quantum theory, including quantum chemistry, quantum statistics, and the theory of quantized fields.

In order to cover such a range of topics in a relatively limited space, the author has restricted himself to concise statements of many basic formulas and to brief and often superficial discussions of general principles, supplemented by extended presentations of selected topics. The resulting book would appear to have its greatest usefulness as a reference book for students reviewing for an examination. For this purpose the section on quantum theory is the least satisfactory, because of its loose organization and a lack of explicitness in the statement of fundamental principles.

As an introduction to quantum theory, the book suffers from the author's choice of the difficult approach through Heisenberg's formulation of matrix mechanics, which is not reproduced or discussed in sufficient detail to make it convincing. The Schrödinger equation is introduced with little discussion; its application to many-particle problems is insinuated rather than stated. Other important matters are introduced in such vague or indirect ways as to be subject to misunderstanding by the reader, or even to suggest a misunderstanding on the part of the author. (The significance of commutation of representative operators in wave mechanics is a case in point.) The book shows some other evidence of haste in preparation; in particular, errors in the discussion of the classical Poisson brackets (page 153) completely obscure the formal similarities of these quantities to their quantum analogs. On the whole, this book cannot be recommended as a class text or for self-instruction.

Hubert M. James
Department of Physics, Purdue University

New Books

Rich Lands and Poor. The road to world prosperity. Gunnar Myrdal. Harper, New York, 1957. 188 pp. $3.

The Invertebrata. A manual for the use of students. L. S. Borradaile and F. A. Potts. Chapters by L. E. S. Eastham and J. T. Saunders. Revised by G. A. Kerkut. Cambridge University Press, New York, 1958. 812 pp. $8.50.

Surface Active Agents and Detergents. vol. II. Anthony M. Schwartz, James W. Perry, Julian Berch. Interscience, New York, 1958. 854 pp. $17.50.

The Annual Survey of Psychoanalysis. A comprehensive survey of current psychoanalytic theory and practice. vol. IV, 1953. John Frosch and Nathaniel Ross, Eds. International Universities Press, New York, 1957. 784 pp. $12.

The Annual Guide to Business Opportunities, Career 1958. For the college man. William H. Ottley, Ed. Careers Inc., 15 W. 45 St., New York, 1958. 224 pp. Free to official agencies in accredited colleges and universities.

Manometric Techniques. A manual describing methods applicable to the study of tissue metabolism. W. W. Umbreit, R. H. Burris, J. F. Stauffer *et al.*, Burgess, Minneapolis 15, ed. 3, 1957. 341 pp. $6.50.

Elementary Practical Organic Chemistry. Pt. II, *Qualitative Organic Analysis.* Arthur I. Vogel. Longmans, Green, New York, 1957. 330 pp. 21s.

XVIth International Congress of Pure and Applied Chemistry. Experientia Suppl. VII. Birkhauser, Basel, 1957. 355 pp.

Textbook of Virology for Students and Practitioners of Medicine. A. J. Rhodes and C. E. van Rooyen. Williams & Wilkins, Baltimore, ed. 3, 1958. 653 pp. $10.

The Neuroses and Their Treatment. Edward Podolsky, Ed. Philosophical Library, New York. 569 pp. $10.

A Manual of Paper Chromatography and Paper Electrophoresis. Richard J. Block, Emmett L. Durrum, Gunter Zweig. Academic Press, New York, ed. 2, 1958. 721 pp. $12.

Calculus. Edward S. Smith, Meyer Salkover, Howard K. Justice. Wiley, New York; Chapman & Hall, London, ed. 2, 1958. 532 pp. $6.50.

Trace Analysis. Papers presented at a symposium on trace analysis held at the New York Academy of Medicine, New York, 2–4 Nov. 1955. John H. Yoe and Henry J. Koch, Jr., Eds. Wiley, New York; Chapman & Hall, London, 1957. 685 pp. $12.

Physical Methods in Physiology. W. T. Catton. Philosophical Library, New York, 1957. 386 pp. $10.

Electrostatics in the Petroleum Industry. The prevention of explosion hazards. A Royal Dutch-Shell Research and Development Report. A. Klinbenberg and J. L. van der Minne. Elsevier, Amsterdam, 1958 (order from Van Nostrand, Princeton, N.J.). 196 pp. $8.

In Search of Reality. Viscount Samuel. Philosophical Library, New York, 1957. 237 pp. $7.50.

Palmer's Fieldbook of Mammals. E. Laurence Palmer. Dutton, New York, 1957. 321 pp. $3.75.

Studies on the Exo-Erythrocytic Cycle in the Genus Plasmodium. London School of Hygiene and Tropical Medicine Memoir No. 12. R. S. Bray. Lewis, London, 1957. 199 pp. £2 2s.

Biochemical Preparations. vol. 5. David Shemin, Ed. Wiley, New York; Chapman & Hall, London, 1957. 124 pp. $4.75.

Soviet Research in Catalysis. vol. 1, *Theoretical and Sundry Associated Effects*, 268 pp.; vol. 2, *General*, 260 pp.; Vol. III, *General*, 256 pp.; vol. IV, *General: Reduction, Oxidation, Fischer-Tropsch*, 228 pp.; vol. V, *Hydrogenation, Dehydrogenation, Cracking*, 300 pp.; vol. VI, *Isomerization, Alkylation, Dehydration*, 278 pp.; vol. VII, *Polymerization, Friedel-Crafts, Zeigler*, 132 pp. English translations. Consultants Bureau, New York 11, 1958. vols. I–VI, $50 each; vol. VII, $30; set, vols. I–VII, $200.

Flora Hawaiiensis or New Illustrated Flora of the Hawaiian Islands. Book 5. Otto Degener. The Author, Mokuleia Beach, Wailua, Oahu, Hawaii, 1958. $5.

Elements of Classical Thermodynamics for Students of Physics. A. B. Pippard. Cambridge University Press, New York, 1957. 172 pp. $4.75.

A Decade of Industrial Relations Research, 1946–1956. Neil W. Chamberlain, Frank C. Pierson, Theresa Wolfson. Harper, New York, 1958. 212 pp. $3.50.

Science and Human Values. J. Bronowski. Messner, New York, 1956. 94 pp. $3.

Land of the Tollund Man. The prehistory and archaeology of Denmark. Palle Lauring. Translated by Reginald Spink. Macmillan, New York, 1958. 160 pp. $6.

The Chemical Industry during the Nineteenth Century. A study of the economic aspects of applied chemistry in Europe and North America. L. F. Haber. Clarendon Press, Oxford, 1958 (order from Oxford University Press, New York). 302 pp. $7.20.

Die Biochemie der Tierischen Gifte. Erich Kaiser and Heribert Michl. Deuticke, Vienna, Austria, 1958. 266 pp.

Cunningham's Manual of Practical Anatomy. vol. I, General introduction. Upper limb, lower limb. Revised by James Couper Brash. Oxford University Press, New York, 1957. 406 pp. $6.

Reports

Reactions of Hexafluorobenzene

The preparation of hexafluorobenzene has been described by several investigators (1–3). Of the methods used, the one of Desirant (2), pyrolysis of tribromofluoromethane, is the simplest and most direct procedure for preparing sizable quantities of hexafluorobenzene. When the procedure is carried out under pressure and with a platinum furnace, this method has produced yields of better than 60 percent (4, 5). Yields of between 20 and 50 percent have been obtained with Pyrex, graphite, and nickel furnaces (4, 5). In addition, other valuable materials—for example, bromopentafluorobenzene and dibromotetrafluorobenzene—are obtained as by-products (4).

Recently, Tatlow *et al.* (3) have shown that hexafluorobenzene reacts with methanolic sodium methoxide at reflux temperature to yield pentafluoroanisole. We have found that pyridine is an excellent solvent in which to perform these nucleophilic replacement reactions. For example, with methanolic sodium methoxide, by use of the inverse procedure—that is, by addition of the base to the hexafluorobenzene-pyridine solution—a 70 percent yield of pentafluoroanisole is realized in a short period of time. Similarly, by use of solid potassium hydroxide pellets in this medium, a 52 percent yield of pentafluorophenol is obtained. However, when alcoholic potassium hydroxide was used as the base to prepare pentafluorophenol, four products were identified by mass spectrometer analysis: pentafluorophenol, 40 percent; tetrafluorodihydroxybenzene, 40 percent; pentafluorophenetole, 4 percent; and tetrafluorodiethoxybenzene, 4 percent. The appearance of the latter two products can be accounted for by postulating the formation of small amounts of potassium ethoxide in the equilibrium mixture of 95 percent ethanol and potassium hydroxide and subsequent reaction with hexafluorobenzene.

The infrared spectrum of pentafluorophenol exhibits a strong hydroxyl band at 2.75 μ and also a band at 2.90 μ, the hydrogen-bonding frequency. The low boiling point (144° to 146°C) of the pentafluorophenol suggests that hydrogen bonding occurs intramolecularly with the ortho fluorine atoms adjacent to the hydroxyl group rather than intermolecularly. The phenomenon is also apparent from the boiling points of *p*-fluorophenol (189°C) and *o*-fluorophenol (152°C) (6). In the former case there is no opportunity for intramolecular hydrogen bonding, only intermolecular, and as a result the boiling point approaches that of ordinary phenol (182°C).

Sodium hydride failed to react with hexafluorobenzene even at its boiling point, when only trace amounts of pyridine were used. This reaction has not been investigated further.

However, when sodium and hexafluorobenzene were sealed in a thick-walled Pyrex tube and heated for ½ hour at 125°C, the tube exploded with severe violence. Apparently, once the reaction has been initiated, it proceeds exothermally at an uncontrollable rate. No reaction occurred at room temperature or at 100°C for 1 hour.

An attempt to couple hexafluorobenzene and methylmagnesium iodide in ether resulted in a 3 percent yield of pentafluorotoluene. It seems likely that a higher-boiling solvent would improve this low yield, and this type of reaction is being actively pursued.

Pentafluoroanisole. Into a three-necked flask were placed 25 g (0.134M) of hexafluorobenzene and 25 ml of dry pyridine. The solution was stirred and heated to 80°C, at which time a solution of 3.45 g of sodium in 40 ml of methanol was added dropwise over a ½-hour period and refluxed for an additional ½ hour. The reaction mixture was cooled and poured into 100 ml of cold 10 percent hydrochloric acid. The bottom organic layer was separated, dried (Na_2SO_4), and distilled. There was obtained 18.66 g (70 percent) of pentafluoroanisole (boiling point 154° to 156°C), reported boiling point 155° to 157°C (3), and 1.04 g (5 percent) of unreacted hexafluorobenzene.

Pentafluorophenol. To 160 g (0.82M) of hexafluorobenzene and 75 ml of dry pyridine, stirred and heated to reflux temperature, was added slowly 90 g (1.62M) of solid potassium hydroxide pellets over a 1.5-hour period. The mixture was refluxed for 1 hour more, cooled, diluted with 100 ml of water, and poured into 200 ml of 10 percent hydrochloric acid. The aqueous solution was extracted with five 100-ml portions of ether. The combined ether extracts were dried (Na_2SO_4) and distilled. There was obtained 50.7 g of unreacted hexafluorobenzene and 56.3 g (52.2 percent based on reacted C_6F_6) of pentafluorophenol, boiling point 72° to 73°/48 mm, 144° to 146°C (micro cap.), N^{26}_D 1.4263. The infrared spectrum showed two bands at 2.75 μ and 2.90 μ.

Pentafluorophenol was also obtained in 20 percent yield by refluxing 5 g of pentafluoroanisole and 25 ml of 47 percent hydriodic acid solution for 48 hours.

Pentafluorophenol reacts readily with benzoyl chloride in pyridine to form pentafluorophenylbenzoate, melting point 76.5° to 78.2°C. Analysis: calculated for $C_{13}F_5H_5O_2$: C, 54.18; H, 1.74; F, 32.9. Found: C, 54.0; H, 2.1; F, 33.2.

Alcoholic potassium hydroxide and hexafluorobenzene. The procedure was the same as that stated above for the pentafluoroanisole, except the following quantities were used: 10 g (0.054M) hexafluorobenzene, 25 ml pyridine, and 6.16 g (0.11M) of potassium hydroxide in 40 ml of 95 percent ethanol. The usual workup gave 9.21 g of a colorless liquid having the following mass spectrometer analysis: 40 percent pentafluorophenol, 40 percent tetrafluorodihydroxybenzene, 4 percent pentafluorophenetole, and 4 percent tetrafluorodiethoxybenzene.

Sodium hydride and hexafluorobenzene. Twenty grams (0.107M) of hexafluorobenzene, 2.64 g (0.106M) of sodium hydride, and 0.56 g of pyridine were refluxed for 5 hours. The reaction mixture was cooled, and water was slowly added until the sodium hydride was destroyed. The organic layer was separated and distilled to give 16 g of unchanged hexafluorobenzene. No other product was evident from the mass spectrometer analysis.

Sodium and hexafluorobenzene. Ten grams (0.054M) of hexafluorobenzene and 2.3 g (0.10 g-atoms) of sodium metal were sealed in an evacuated, 8-inch-long, heavy-walled, Pyrex tube and allowed to stand at room temperature for 72 hours. There was no apparent reaction. The tube was inserted in an oil bath at 50°C, slowly raised to 100°C, and held at this temperature for 1 hour. The sodium blackened slightly, and some solid ma-

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All technical papers are published in this section. Manuscripts should be typed double-spaced and be submitted in duplicate. In length, they should be limited to the equivalent of 1200 words; this includes the space occupied by illustrative or tabular material, references and notes, and the author(s)' name(s) and affiliation(s). Illustrative material should be limited to one table *or* one figure. All explanatory notes, including acknowledgments and authorization for publication, and literature references are to be numbered consecutively, keyed into the text proper, and placed at the end of the article under the heading "References and Notes." For fuller details see "Suggestions to Contributors" in *Science* **125**, 16 (4 Jan. 1957).

terial was visible, probably sodium fluoride. The temperature was then raised to 125°C, and after ½ hour the tube exploded with extreme violence. Nothing was recoverable.

Pentafluorotoluene. To the Grignard reagent prepared from 1.31 g (0.054 g-atoms) of magnesium turnings and 13.07 g (0.054*M*) of methyl iodide in 15 ml of anhydrous ether, was added 10 g (0.054*M*) of hexafluorobenzene. Slight refluxing of the ether was observed during the addition. The mixture was refluxed for 2 hours more, cooled in ice, and decomposed by the addition of 50 ml of cold 10 percent hydrochloric acid. The organic layer was separated, dried (Na_2SO_4), and the ether was removed. The residual liquid, 7.1 g, was analyzed by mass spectrometer and found to contain 65 percent unreacted hexafluorobenzene, 3 percent pentafluorotoluene, and 20 percent of a nonvolatile residue which has not been characterized (*7*).

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14 November 1957

Homing in Nonmigratory Bats

Homing at high speeds (*1*) and over long distances (*2*) has been observed in species of bats which normally migrate and which may have some familiarity with the territory covered. Although the means by which a bat navigates in returning to its roost are not known, it is known that visual and auditory clues are important factors in the homing of birds (*3*). In order to test the importance of these factors in bat movements, experiments are being conducted with the big brown bats, *Eptesicus fuscus fuscus*, which seems to be nonmigratory in the Cincinnati, Ohio, area. Bats collected from roosts in Cincinnati were carried north or south and released in locations with which they were not familiar.

The 155 bats taken north were captured, weighed, and banded on 20 July 1957. These bats were divided into five groups according to the amount of wear on their teeth—the higher the number of the group, the older the bats in the group (*4*). This criterion indicates only the relative age and not years (*5*). However, the season's young, born during the last week in May and the first week in June, were distinguishable. Of the 155 bats, all of the 57 males and 47 of the 98 females were juveniles. Among the other females, 16 were from group 2, 21 were from group 3, 7 were from group 4, and 7 were from group 5. All of these females had borne young, and the mammary glands had regressed. On 21 July they were transported in the trunk of an automobile in cages surrounded with crushed ice, since the temperature was in the middle 90's. The bats seemed torpid.

The bats were reweighed and released in the late evening at Pilgrim, Mich., north of Frankfort, 450 miles north of their home roosts. The temperature was below 70°, and many of the bats had to be exercised individually before they would fly voluntarily.

The roosts were rechecked on 24 August. Three bats were recaptured, all adult females. Two of these—one from group 2 and one from group 5—had been banded for the first time on 20 July; the third, from group 4, had been recaptured from the same roost nine times in eight different calendar months over a period of 2 years. Two other bats were observed after release. One juvenile male was killed 3 days after release, two miles north of the point of release; another juvenile male was observed about a mile south on the day following release. On 26 Oct., four more females were recaptured after they had returned from Michigan, two from group 3 and one each from groups 4 and 5.

For the southern trip, only 18 bats (nine males and nine females) could be captured on 31 July in Cincinnati. Eight of the males and six of the females were juveniles; one male and one female were from group 2; one female was from group 3, and one was from group 4. These were released at Reelfoot Lake, Tenn., 340 miles to the southwest, on 2 Aug. 1957. The temperature was 95°F, and all the bats flew immediately upon release. On 17 Aug., two of these bats were recaptured at the original roost in Cincinnati. One was a female from group 4 which had previously been captured nine times in seven different calendar months, from April through December, over a period of 2 years. The other was a juvenile male about 2 months old. Another of the juvenile males released at Reelfoot Lake was killed in Charleston, Ill., on 10 Sept. This bat was already north of the latitude of Cincinnati and 200 miles to the west.

The big brown bats seem to be nonmigratory in the Cincinnati area, since individual banded specimens have been collected in ten different calendar months. Two of the bats that returned during these experiments had been recaptured nine times in the previous 2 years. The juvenile male about 2 months old was certainly not familiar with the territory covered. Both of the bats that returned from Tennessee gained weight on the trip, whereas five of the seven bats that returned from Michigan lost weight. Two of 18 (11 percent) bats returned from Tennessee; seven of 155 (4.6 percent) returned from Michigan. However, the difficulties encountered in collecting bats in large attics and barns make our recapture figures minimal, and no significance can be attached to the difference in percentage of bats returned.

In our experiments, bats returned 450 miles south within a month or less, and 340 miles northeast within 2 weeks or less, to their original roosts, over unfamiliar territory (*6*).

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6-Aminonicotinamide and Acute Degenerative Changes in the Central Nervous System

Two analogs of nicotinic acid and nicotinamide, 3-acetylpyridine (3-AP) and 6-aminonicotinamide (6-AN), cause toxic effects in mammals which are prevented by the administration of the metabolite and some of which resemble nicotinic acid deficiency (*1, 2*). Neurological changes appear to be a prominent feature of the intoxication. As examples, mice given 3-AP lose control of the hind legs and eventually become almost completely paralyzed (*1*); in nicotinic acid deficient dogs a toxic dose of 3-AP causes limb paralysis (*3*); and 6-AN in oral doses of 15 to 30 mg/kg produces in rats and rabbits loss of motor control and paralysis (*4, 5*). We undertook a toxicological study of 6-AN in preparation for its possible clinical use as an anticancer agent (6). Its potential in this regard is based on reports of its inhibitory activity against several experimental tumors (4, 7). In an attempt to determine the nature of the paralytic effects, we observed characteristic lesions in the central nervous system in rats. Subsequent study revealed the presence of similar lesions in paralyzed cats and dogs.

A single intraperitoneal injection of 8 mg/kg was given to 47 male rats (the Nelson subline of Carworth Farms Wistar) which weighed between 212 and 303 g and which were maintained on a stock diet (8). Nineteen were killed under ether anesthesia at various times between 1 and 10 days; 18 others died between 1 and 11 days (the majority during the second and third days); the remaining 10 rats survived. Incoordination of the hind legs was evident in almost all rats within 24 hours after the injection. By the second day paralysis was present in the hindquarters and the more affected rats were unable to stand. At 3 days and later, all extremities were involved in the sicker individuals, and by 10 days the muscles of the hind legs were wasted. Five of the survivors were also paralyzed during the first week; but these eventually recovered and by the end of the third week after injection were outwardly normal.

Spinal cords and brains were obtained for pathological study at different times from animals which were judged to be the most disturbed: three at 1 day, two at 2 days, one at 4 days, and one at 10 days after injection. Marked destruction was found in anterior horn cells in the spinal cord and in nuclei within the brain stem. The lesions were detectable as early as 24 hours after the injection, when they consisted of petechial hemorrhages and early degenerative changes in neurons. These changes were maximal by 4 days, when they were characterized by advanced necrosis and disappearance of cell bodies (Fig. 1).

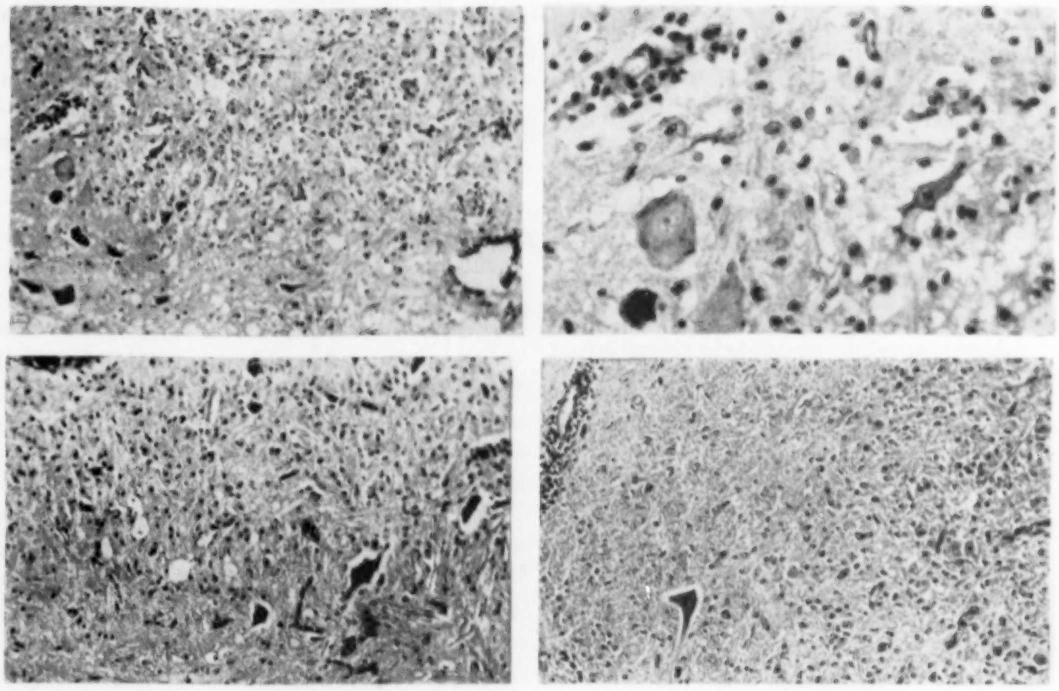

Fig. 1. Sections of spinal cord or brain stem stained with hematoxylin and eosin. (Top left) Rat spinal cord 4 days after a single intraperitoneal dose of 8 mg/kg of 6-AN. A major portion of the anterior horn is destroyed. At lower left a few neurons persist. (Top right) Higher power from area at left of the photograph in top left. At right, area of severe damage with shrunken neuron containing pyknotic nucleus. At upper left, cellular infiltration around capillary. (Bottom left) Cat spinal cord 9 days after single intravenous dose of 30 mg/kg of 6-AN. Severely damaged anterior horn. A few intact but damaged neurons at periphery. (Bottom right) Same animal as that shown at bottom left. Severe damage to brain stem nucleus, especially at right. Perivascular cuffing at left.

Three cats were injected intravenously with 30, 15, and 7.5 mg/kg of 6-AN. Dysmetria was noted within 5 hours in the hindquarters of the animal given the highest dose. The disturbance advanced and at 72 hours all four limbs were paralyzed. The knee-jerk and the placing reflex were still active in the hind legs, and ipsilateral flexion could be elicited by pinching the toe-pads. By 10 days the hind leg muscles were wasted. The animal was killed with pentobarbital sodium, and the central nervous system was removed for microscopic study. Lesions were found in the spinal cord and brain stem similar to those seen in paralyzed rats (Fig. 1). The two surviving cats also developed severe postural disturbances which were maximal at 72 hours after injection. Thereafter the pair recovered steadily; but 4 months later the animal that had been given the higher dose still showed dysmetria in its hind legs.

Five dogs, given repeated daily doses of 4 mg/kg per day either intravenously or by mouth, showed varied responses. One tolerated ten doses without evident disturbance. Another, after seven doses, was hyperexcited, hyperthermic, and uncoordinated and showed continuous twitching of the ears and cheeks. Unfortunately it died unobserved during the eighth day. A third animal received ten doses during 11 days of treatment and died at 18 days. During the last week a variety of neurological disturbances developed: continuous bobbing of the head except during or immediately after purposeful movements, twitching of the ears and lips, and incoordination of hind legs. The last two dogs became paralyzed in all four extremities after 1 week of treatment. At this time patellar and flexion reflexes were active, and there were no signs of central excitation. The animals swallowed with difficulty and salivated excessively. They were killed at 8 and 10 days by means of intravenous administration of pentobarbital sodium. As in the two previous species, lesions were found in the anterior horn of the spinal cord and in brain stem nuclei (9, 10).

Such neuropathological damage is unusual in its severity and in its selective localization in the gray matter of the anterior horn and of the brain stem. Possibly its occurrence is related to the capacity of central nervous tissue to synthesize in vitro the 6-AN analog of diphosphopyridine nucleotide through exchange reactions (12). The formation of the 3-AP analog of diphosphopyridine nucleotide has also been shown to occur in brain tissue, and it has been suggested that this reaction is responsible for the toxic effect of 3-AP (13). However, lesions similar to those produced by 6-AN have not been observed in animals given 3-AP (14).

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10. This report has dealt only with the findings related to the central nervous system. A description of the course of intoxication, the hematological changes, and the visceral lesions is in preparation. After this study was completed, our attention was drawn to a description of the pathological effects of 6-AN in young rats and mice (*11*).
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18 November 1957

Influence of Gibberellin on Xanthium Flowering as Related to Number of Photoinductive Cycles

In 1956 Lang (*1*) reported that biennial *Hyoscyamus niger,* when treated with gibberellin, bolted and bloomed the first season without cold or long-day treatments and that the long-day, annual form of this species bloomed under short days when treated with gibberellin. As early as 1928 Kurosawa (*2*) had noted that rice plants infected with *Gibberella fujikuroi,* the fungus which produces gibberellin, flowered earlier than uninfected plants. In 1951 Mitchell, Skaggs and Anderson (*3*) reported that bean plants, when treated with gibberellin, bloomed earlier than the controls. Lang, however, was the first to demonstrate that gibberellin could substitute for long-day and low-temperature treatments in the induction of bolting and initiation of flowering.

Soon after his first papers appeared, Lang (*4*) and other investigators, including Bünsow and Harder (*5*), Lona (*6*), Lona and Bocchi (*7*), Marth, Audia, and Mitchell (*8*), and Wittwer and associates (*9*), reported on the initiation or promotion of reproductive development by gibberellin in various other species of plants. Of the 38 species studied, 17 have been long-day annuals, 9 biennials, 9 day-neutral annuals, and 3 short-day annuals. Gibberellin has proved to be a substitute for long-day and cold treatments for all species in the first two groups, except rye and *Perilla.* While induction of reproductive development was not involved in the day-neutral species, gibberellin hastened flowering in all species studied except pepper and geranium. No success has been reported, however, with the few short-day species studied. Lang (*4*) found that Biloxi soybeans and *Xanthium,* when treated with gibberellin, remained strictly vegetative under long photoperiods. Marth, Audia, and Mitchell (*8*) observed earlier blooming in gibberellin-treated saliva, but the plants were apparently already induced. Lang (*4*) reached the following conclusion: "It thus appears that application of gibberellin allows numerous plants to overcome cold and long day requirements in flower formation but that it does not substitute for any short day requirement."

The present study, which was initiated before the publication of Lang's results with soybeans and *Xanthium,* was designed to secure information on possible effects of gibberellin on the reproductive development of *Xanthium pennsylvanicum,* which is one of the best known short-day species. A preliminary experiment, in which both gibberellin-treated plants and controls were kept continuously under both long and short photoperiods, confirmed Lang's observations that gibberellin would not induce reproductive development in *Xanthium* under long photoperiods.

In the experiment reported here all plants were kept under long photoperiods (18 hour minimum) for 28 days following the date of planting (15 July 1957). At that time 30 plants were set aside as controls and 30 were treated with gibberellin in the form of a $10^{-3}M$ solution of gibberellic acid (*10*) in 0.25 percent Dreft, each plant receiving 1 ml of the solution as drops applied to the leaves with a pipette. The controls were similarly treated with the 0.25 percent Dreft solution alone. Five controls and five treated plants were continued under long days, and 25 of each were placed under 8-hour photoperiods in the greenhouse by means of an automatic short-day device (*11*). After two photoinductive cycles, five plants of each group were returned to long photoperiods. This process was repeated on alternate days, providing groups of plants which had received two, four, six, eight, ten, and twelve photoinductive cycles. The data reported here was taken 21 days after the beginning of the short-day treatments.

The stem growth of the gibberellin-treated plants was much greater than that of the controls in all photoperiodic treatments (Table 1), the gibberellin overcoming the reduction in stem growth produced in the controls by four or more photoinductive cycles. All gibberellin-treated plants had more nodes than the controls, though this may have been due to accelerated internode elongation rather than to the formation of additional nodes. Stem diameter was

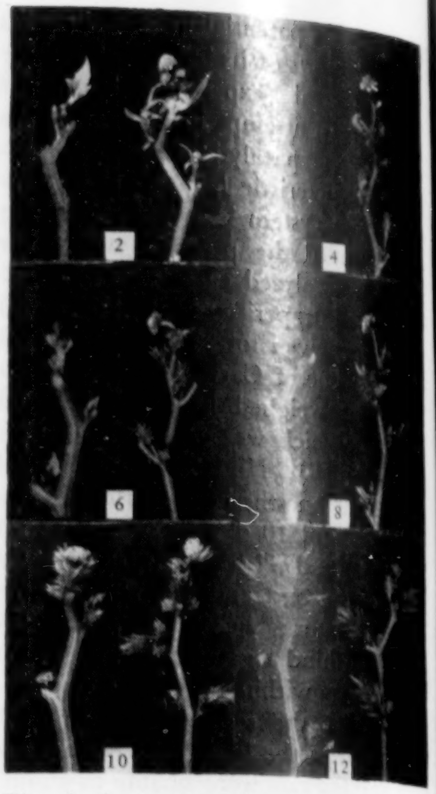

Fig. 1. Stem tips of representative *Xanthium* plants given 2 to 12 photoinductive cycles (figures between each pair of tips). The right-hand tip of each pair was from a plant treated with gibberellin, the left-hand tip from a control plant (× ½).

Table 1. Influence of gibberellin and photoperiod on the growth and reproductive development of *Xanthium pennsylvanicum* during a 3-week period after treatment.

Number of photo-inductive cycles	Mean stem growth (cm)		Number of nodes visible		Inflorescence buds formed	
	Controls	Gibberellin	Controls	Gibberellin	Controls	Gibberellin
0	27.0	54.7	5	8	–	–
2	25.6	62.3	5	8	–*	+†
4	17.0	55.1	4	8	–*	+
6	20.6	66.7	5	8	+	+
8	15.6	57.2	5	7	+	+
10	18.9	57.4	4	7	+	+
12	15.7	50.1	5	6	+	+

* Inflorescence primordia present in all five plants.

† Four plants with macroscopic inflorescence buds, one with inflorescence primordia.

not measured, but the gibberellin-treated plants all had stems which were obviously more slender than those of the controls (Fig. 1). At the end of the experiment, plants that had been retained continuously under long days were still strictly vegetative, while all plants that had been given six or more photoinductive cycles had well-developed macroscopic flower buds. The control plants that had been given two and four photoinductive cycles had developed only microscopic inflorescence primordia—stages 2 and 3 of Salisbury (*12*)—while all but one of the gibberellin-treated plants given two or four cycles had well-developed macroscopic flower buds, which were farther along than the controls which had received eight inductive cycles (Table 1; Fig. 1). Gibberellin also accelerated reproductive development in the six-, eight-, and ten-cycle groups, particularly with regard to pistillate inflorescences in the latter group.

These results substantiate Lang's conclusion that gibberellin does not substitute for any short-day requirement of *Xanthium* as far as ***initiation*** of reproductive development is concerned. Various investigators, including Mann (*13*), Naylor (*15*), and Salisbury (*12*), have shown that, while one photoinductive cycle is sufficient for the induction of *Xanthium,* additional cycles increase the rate of reproductive development. Gibberellin *can* substitute for such additional photoinductive cycles in promoting the reproductive development of induced *Xanthium* plants.

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8 November 1957

Note on Absorption Spectra of Hill Reaction Oxidants

The selection of oxidants for the Hill reaction has been somewhat empirical heretofore. Mainly, complex inorganic ions and quinones have been found to be good Hill reaction oxidants. Hill and Whittingham (*1*) have listed the oxidation potentials of common oxidants. These range from −0.44 for ferricyanide to 0 for ferrioxalate.

Yet surely the oxidation potential alone does not determine the suitability of an electron acceptor for the Hill reaction. For one thing, some oxidants of really negative potentials, which therefore should be easily reducible, are not reduced by illuminated chloroplasts. Examples of this kind are permanganate and periodate, neither of which participates in the Hill reaction at all (*2*).

It became of interest, therefore, to investigate some of the other characteristics which might influence the activity of various oxidants in the Hill reaction. For this reason, we have investigated the absorption spectra of various Hill reaction oxidants (*3*). The pertinent data are collected in Table 1. It is clear that Hill reaction oxidants absorb light near the blue peak of chlorophyll *a,* whereas the light absorption of those compounds which are inactive as Hill reaction oxidants is negligible around 420 to 430 mμ. This appears to be true despite the fact that the latter group includes compounds which are good oxidizing agents, such as permanganate and periodate. One test of this prediction was the finding that cobaltioxalate, which possesses the required absorption band at 420 mμ, acts as an electron acceptor in the Hill reaction (*4*).

Unfortunately, a real physical explanation of these facts cannot be given now. Neither the term levels of chlorophyll nor the term levels of complex inorganic ions are well enough characterized that an elucidation of their absorption spectra is possible at this time. The following explanation of the correlation which appears in Table 1 may, however, provide a reasonable approach to the problem.

It is well known that the Franck-Condon principle requires an overlap of energy levels of the reactants, because the actual time taken by electron transfer and by electronic excitation energy transfer is short compared with the time for ordinary atomic motion. If we consider that electronic excitation energy transfer from chlorophyll to the oxidant occurs in the Hill reaction, then the Franck-Condon principle requires chlorophyll and the Hill reaction oxidant to have overlapping energy levels. In the absence of precise knowledge of energy levels of chlorophyll and ordinary Hill reaction oxidants, which has already been referred to, the additional assumption has to be made that overlapping absorption bands in the absorption spectra of two substances also indicate overlapping energy levels. The data of Table 1 indicate that good Hill reac-

Table 1. Absorption peaks of chlorophyll *a* and of various hill reaction oxidants.

Hili reaction		Absorption		
Oxidant	Ref.	mμ	Log ε	Ref.
		Chlorophyll a		
		250	∼4.43	*10*
		325*	4.41	*11*
		375*	4.69	*11*
		427.5*	5.08	*12*
		660*	4.96	*12*
		Ferricyanide		
Yes	*13*	260	3.28	*14*
		303	3.36	*14, 15*
		420	3.04	*15*
		p-*Benzoquinone*		
Yes	*16*	240	4.7	*17*
		300	2.5	*17*
		425	1.4	*17*
		Cobaltioxalate		
Yes	*4*	245	4.33	*18*
		420	2.34	*18*
		596	2.22	*18*
		1,2-*Naphthoquinone*		
Yes	*19*	250	4.35	*20*
		340	3.40	*20*
		400–500	3.4–2.0	*20*
		420	∼3.0†	*20*
		1,4-*Naphthoquinone*		
Yes	*19*	250	4.4	*21*
		335	3.5	*21*
		400	1.7	*21*
		425	1.6	*21*
		Phenol-indophenol		
Yes	*2*	420	3.0†	*22*
		Ferrioxalate		
Yes	*23*	420	1.4†	*24*
		Chromate		
Yes	*2, 25*	280	3.58	*26*
		380	3.66	*26*
		420	2.7†	*4*
		Vanadate		
No	*2*	310–370	cutoff	*27*
		Thionine		
No	*2*	240	4.08	*28*
		285	4.64	*28*
		585	4.60	*29*
		Permanganate		
No	*2*	310	3.23	*30*
		525	3.35	*30*
		545	3.33	*30*
		Nitrate		
No	*2*	200	4.1	*31*
		300	2.53	*27*
		Cobalticyanide		
No	*4*	200	>4	*32*
		259	2.15	*32*
		311	2.2	*32*
		Tetrathionate		
No	*2*	216	4.0	*33*
		Hypochlorite		
No.	*2*	290	2.54	*34*
		Periodate		
No	*2*	222.5	4.0	*35*
		Methylene blue		
Yes	*36*	250	4.30	*28*
No	*2*	290	4.65	*28*
		615	4.57	*29*
		662	4.83	*29*

* In ethyl ether. † Continuous absorption, not a maximum.

tion oxidants do indeed have absorption bands which overlap the blue absorption band of chlorophyll. The evidence that methylene blue is an electron acceptor is conflicting in the literature.

It may well be asked where the energy for electron transfer at an energy level corresponding to the 420-mμ absorption band (68 kcal/mole) comes from, since the Hill reaction proceeds, as does photosynthesis, in red light (44 kcal/mole). It will be noted that at least 24 kcal/mole remain unaccounted for.

Another light absorption step may provide the additional energy needed. No such two-step process which uses only the short-lived singlet states can occur. Excitation of chlorophyll to a "chemically active species" may, however, be explained as occurring in a two-step process analogous to the one occurring in the flash photolysis of anthracene and related substances (*5*). This is based on the existence of a metastable state (triplet) of chlorophyll with a life-time of about 10^{-3} sec (*6*). The energy of the metastable state is slightly below that of the first (singlet) excited state of chlorophyll; experimental evidence which indicates its participation in photosynthesis has been obtained by Calvin (*7*) and by Commoner (*8*).

Thus we picture radiant energy to be converted to chemical energy in the course of the Hill reaction in the following two-step process. The first step is excitation to either the first or second excited singlet state, but only the molecules remaining in the long-lived metastable state are of further interest. These may be promoted by absorption of another quantum of red light to provide the additional energy required for ultimate reduction of the oxidant (*9*).

One consequence of this two-step energy absorption process is that the quantum requirement for the formation of molecular oxygen cannot be less than eight. Two quanta are required to promote each of the four electrons involved for wavelengths corresponding to either the red or the blue absorption bands of chlorophyll (*10*).

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3 September 1957

Serotonin, Norepinephrine, and Related Compounds in Bananas

The present study was initiated following a personal communication from J. A. Anderson (*1*) that ingestion of bananas produces an increased urinary excretion of the serotonin (5-hydroxytryptamine) metabolite, 5-hydroxyindoleacetic acid. This observation was reported recently by Anderson, Ziegler, and Doeden (*2*). The chemical studies reported here were undertaken to explain this phenomenon; they have led to the rather surprising finding that bananas contain large amounts of two physiologically important agents, serotonin and norepinephrine.

Table 1. Serotonin and catecholamines in banana. The values presented are the averages of a number of analyses on ripe, yellow bananas. In the case of serotonin, 14 assays were done on pulp (range, 8 to 50 µg/g) and 5 on peel (range, 47 to 93 µg/g). In the case of norepinephrine and dopamine, the values represent the results obtained on three bananas.

Pulp*		Entire peel†	
µg/g	mg/banana	µg/g	mg/banana
	Serotonin		
28	3.7	65	3.9
	Norepinephrine		
1.9	0.25	122	7.3
	Dopamine		
7.9	1.0	700	42

* Average wt. of pulp, 130 g.
† Average wt. of peel, 60 g.

The studies started with an attempt to find serotonin in bananas. Extracts of banana pulp were prepared by homogenization in 0.1*N* HCl followed by alkalinization and extraction as described by Weissbach *et al.* (*3*). Homogenates of banana peel were precipitated with $Zn(OH)_2$ and the filtrates were used for assay (*3*). Spectrophotofluorometric analysis of these extracts revealed large amounts of material having the characteristic activation and fluorescence spectra of serotonin (*4*). The amounts found are shown in Table 1. The serotonin in these extracts was identified further by subjecting it to chromatography on paper. As is shown in Table 2, the R_f values in two solvent systems and the colors obtained with several spray reagents were identical with those obtained with an authentic sample of serotonin.

The presence of related 5-hydroxyindole compounds was also investigated. No 5-hydroxyindoleacetic acid was found by use of the quantitative assay procedure (*5*). Chromatography of acetone-HCl extracts (see below) revealed the presence of at least two other 5-hydroxyindole substances. No further identification of these substances was attempted in the present study.

The presence of serotonin, coupled with the fact that bananas produce melanin-like material on ripening, suggested the possibility of oxidation of 5-hydroxyindoles to "melanin-precursors," 5,6-dihydroxyindole compounds (*6*). The presence of "melanin-precursors" was further suggested by the observation that extracts adjusted to neutral or basic pH values blackened rapidly. To investigate the presence of such compounds, banana pulp and peel were homogenized in five volumes of acetone-2N HCl (12:1) and centrifuged. The supernatant fluid was concentrated by heating it on a water bath at 70°C. The volume was then adjusted so that 1 ml represented 0.5 g of original tissue. Portions of these extracts were applied to Whatman No. 3 paper, and chromatograms were developed overnight with phenol (see Table 2).

The chromatograms were sprayed with ferricyanide reagent which gives a blue color with 5,6-dihydroxyindole compounds. Although little, if any, such material was revealed, a large number of substances appeared which had the characteristic pink color of oxidized catecholamines. None of these were indoles, as was shown by their failure to give the characteristic color with Ehrlich's reagent. A comparison of the chromatographic behavior of these substances with known catecholamines (see Table 2) revealed the presence of norepinephrine and 3,4-dihydroxyphenylethylamine (dopamine). In addition to having R_f values identical with those of the authentic compounds, these substances gave the same colors and fluorescence following spraying with ferricyanide reagent. Each substance was eluted from the paper with dilute HCl and converted to its respective fluorophor by a modification (*7*) of the Lund procedure (*8*). The activation and fluorescence spectra were identical with those formed from reference standards (activation, 390 mμ; fluorescence, 510 mμ). The amounts of norepinephrine and dopamine in pulp and peel were determined by chromatographing measured aliquots of the acetone-2N HCl extracts, eluting the appropriate areas, and assaying fluorometrically (*7*).

Table 2. Chromatographic identifications.

Compound	Phenol system*			N-Propanol-1N ammonia (5:1)		
					Color	
	R_f	Color†	Fluorescence‡	R_f	Ehrlich reagent	Nitroso-Naphthol reagent
1	0.55	Yellow	Pink	0.52	Blue	Purple
Serotonin	0.56	Yellow	Pink	0.53	Blue	Purple
2	0.38	Pink	Blue			
Dopamine	0.38	Pink	Blue			
3	0.12	Pink	Yellow			
Norepinephrine	0.12	Pink	Yellow			

* 80 g of phenol, 20 ml of 0.02N HCl, several milligrams of KCN, saturated with SO_2.
† After spraying with ferricyanide reagent (0.4 percent ferricyanide in 0.1M phosphate buffer, pH 7).
‡ As seen under ultraviolet light after spraying with ferricyanide reagent.

The results shown in Table 1 indicate that banana contains large amounts of norepinephrine and the related substance dopamine. The biologic activity of these catecholamines was studied as further proof of their identity and to ascertain whether the norepinephrine was the physiologically active, L-form. Aliquot portions of banana eluates containing known amounts of these substances as determined fluorometrically were injected into dogs, and the effects on arterial blood pressure were compared with those obtained with synthetic L-norepinephrine and dopamine. As is shown in Fig. 1, the pressor responses obtained with 10 μg of extracted norepinephrine and the synthetic L isomer were comparable. In the case of dopamine, 1 mg of both the extracted material and the standard produced an identical rise in blood pressure, amounting to 120/60 mm-Hg.

The presence of related catecholamines was also investigated. Large amounts of material having chromatographic properties similar to 3,4-dihydroxyphenylalanine (DOPA) were found in all the extracts examined. Although it is likely that the banana is rich in DOPA, further identification of this substance is required. There appears to be at least one additional catecholamine substance in banana. This material had an R_f in the phenol system of about 0.05, unlike any of the available reference standards. No epinephrine has as yet been demonstrated in banana extracts. It was found that the extracts do not contain histamine.

Although 5-hydroxyindoleamines have been found in plants previously, they have usually been associated with plants regarded as toxic to animals (*9, 10, 11*). To our knowledge this is the first report of the finding of norepinephrine in plant material. The significance of these two amines in the metabolism of the banana is not obvious although they may play a role in the browning reaction.

The presence of these potent physiologic agents in a food as widely used as the banana is of clinical interest. Serotonin is known to inhibit gastric secretion and to stimulate smooth muscle in the intestine (*12*) and elsewhere; norepinephrine is an important mediator of autonomic function and is used extensively as a vasoconstrictor agent. Whether the oral administration of these amines through banana feeding can have effects on the gastrointestinal tract or on the cardiovascular system remains to be determined. One might also speculate about whether some of the reported therapeutic uses of bananas (*13*) (in celiac disease, peptic ulcer, constipation, and so forth) may be due to the presence of these amines. As a result of these findings, we were encouraged to administer large amounts of serotonin to patients. It was found that at least 20 mg of serotonin can be taken orally without any apparent physiologic effect. In contrast, as little as 1 mg of serotonin produces marked effects when it is administered intravenously. Although no comparable information is available concerning oral administration of norepinephrine, Richter has administered as

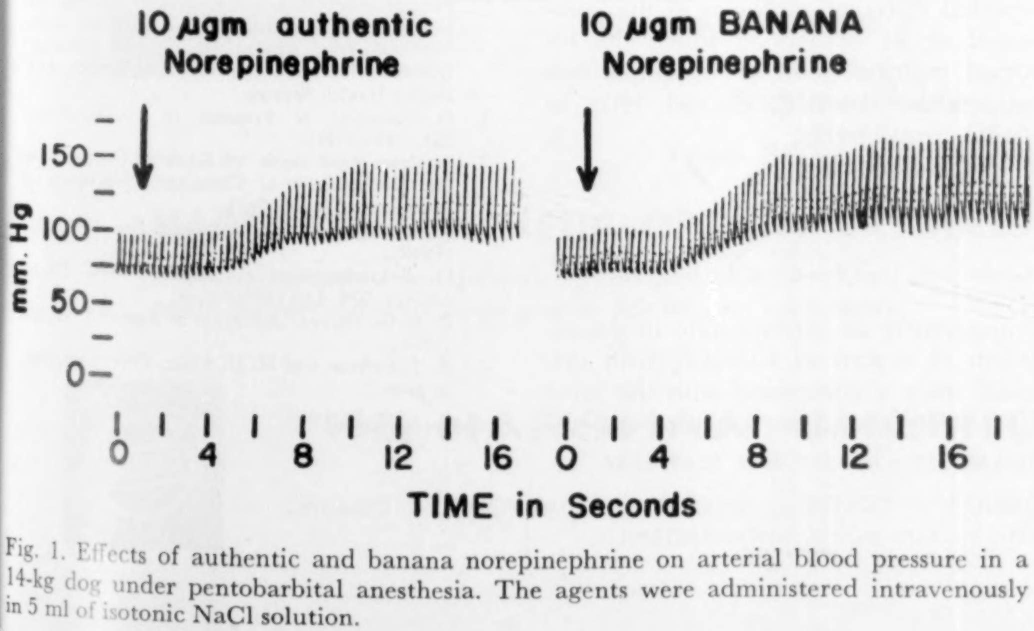

Fig. 1. Effects of authentic and banana norepinephrine on arterial blood pressure in a 14-kg dog under pentobarbital anesthesia. The agents were administered intravenously in 5 ml of isotonic NaCl solution.

much as 30 mg of epinephrine to human beings via the oral route (*14*). However, physiological changes were observed at this level.

Of immediate clinical significance is the fact that ingestion of bananas may lead to erroneous chemical diagnoses of carcinoid tumors (*2*) and pheochromocytoma by producing an increased urinary excretion of serotonin and norepinephrine and their metabolites. Also, bananas should be eliminated from the diets of patients whose urinary indoles and catecholamines are being measured for other purposes—for example, in mental disease. It remains to be determined whether other edible plants contain these agents.

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12 February 1958

2-Thiazolidinethione-4-Carboxylic Acid from the Reaction of Captan with Cysteine

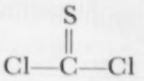
In studies of the mechanism of fungitoxic action of captan [N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide] (*1*), it was found that certain sulfhydryl compounds react with this fungicide to form ultraviolet absorbing products. A compound with an absorption maximum at 272 mμ is formed when cysteine is reacted with captan or trichloromethylsulfenyl chloride ($ClSCCl_3$). The evidence presented in this paper demonstrates that the ultraviolet absorbing compound formed in the reaction between captan and cysteine is 2-thiazolidinethione-4-carboxylic acid.

This compound was made by reacting captan and L-cysteine in aqueous solutions. Tetrahydrophthalimide formed in this reaction was removed by extraction at *p*H 6.0 with ethyl acetate, and 2-thiazolidinethione-4-carboxylic acid was then removed at *p*H 1.5 with the same extractant. The latter was further purified by passing it through ethyl acetate and sodium carbonate solutions in the manner described for purifying the hydrazones of keto acids (*2*). The purified compound was converted to the sodium salt and recrystallized from ethanol by addition of excess ethyl ether. The sodium salt was dissolved in water and converted to the acid form, which was then extracted with ethyl acetate. White to pale yellow crystals formed upon evaporation of the ethyl acetate.

The following evidence was obtained for the identity of the compound. The equivalent weight was determined by base titration. Ninhydrin and nitroprusside tests were negative but were positive when cysteine was reformed upon base hydrolysis or partial reduction of the compound. Values obtained by analyses for carbon, hydrogen, nitrogen, and sulfur were comparable to the theoretical values (*3*). The ultraviolet absorption of the compound is similar to that for 2-thiazolidinethione (Fig. 1). Infrared analysis suggested the presence of a secondary amine, a thioureide, and a carboxyl structure in the molecule.

The melting point of the compound was 180 to 181°C. Chatterjee *et al.* (*4*) and Behringer and Zillikens (*5*) have reported different syntheses of the compound or its isomers in which the reported melting point or decomposition temperature was 161°C and 190° to 194°C, respectively.

Thiophosgene



$$Cl{-}\overset{\overset{\displaystyle S}{\|}}{C}{-}Cl$$

is apparently an intermediate in the reaction of captan or $ClSCCl_3$ with cysteine, since a compound with the same ultraviolet absorption spectrum and the same chromatographic R_f value as 2-thiazolidinethione-4-carboxylic acid is formed when thiophosgene is reacted with cysteine. Barron (*6*) reported that cysteine reacts with phosgene to form 2-thiazolidone-4-carboxylic acid. Apparently thiophosgene behaves the same as phosgene in its reactivity with cysteine.

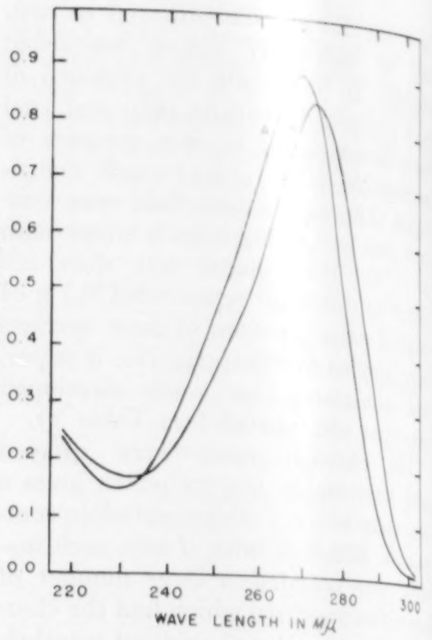


Fig. 1. Comparison of the ultraviolet absorption spectrum of 2-thiazolidinethione with that of 2-thiazolidinethione-4-carboxylic acid. Curve *A*, 2-thiazolidinethione, $6.1 \times 10^{-5} M$; curve B, 2-thiazolidinethione-4-carboxylic acid, $6.1 \times 10^{-5} M$.

A description of other products of the reaction of captan with cysteine and the significance of the reaction in the fungitoxic mechanism of captan is presented elsewhere (*7*).

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References and Notes

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20 December 1957

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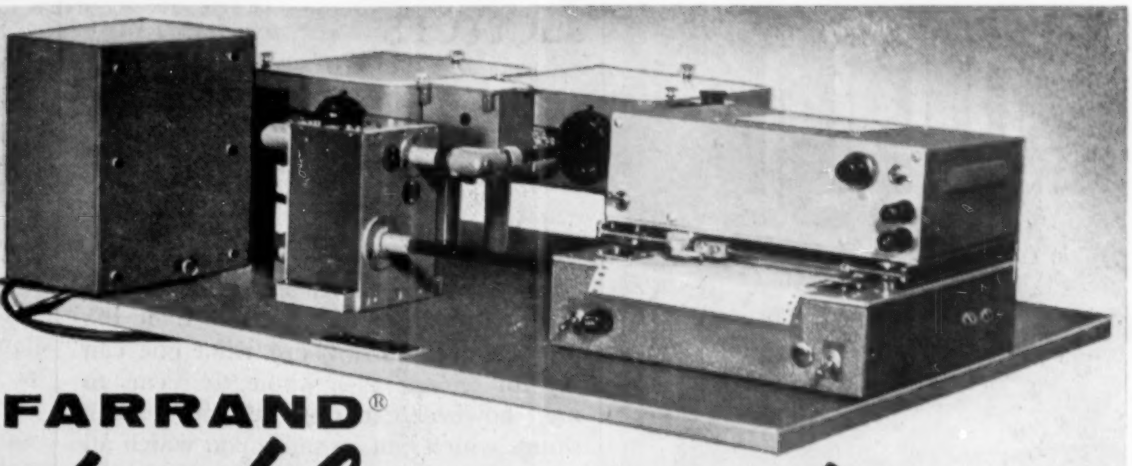

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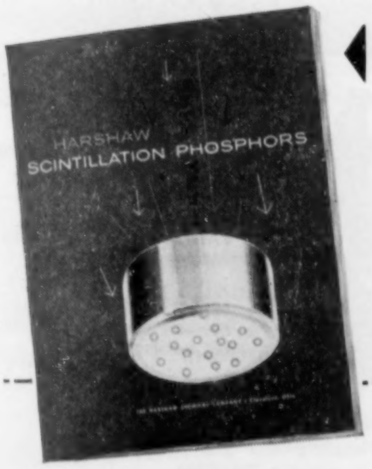

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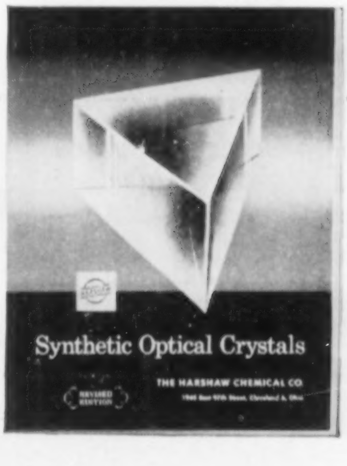

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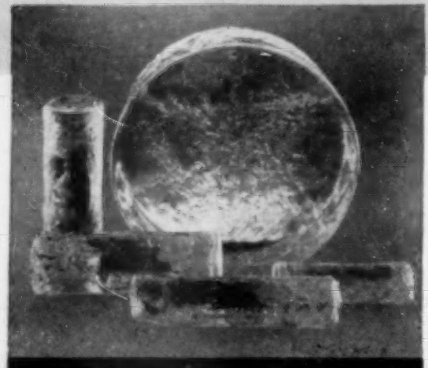

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Letters

Role of Scientific Societies

I was interested in the editorial in the 10 January issue of *Science* [**127**, 57 (1958)]. We are particularly sensitive to the point which you mentioned of the difficulty of knowing just what one can say for science as a whole. It seems to me, however, that there are certain things which can be said upon which all scientists agree—things that should be said.

I have in mind, for example, the importance of a rigorous basic education in science, which a large portion of our informed citizenry should have. Further, all scientists will probably agree on the need for greater emphasis on basic research and a better understanding on the part of the public of the importance of basic research. Unless the scientist, or an organization representing scientists, speaks out for such things, scientific progress is very likely to suffer. In other words, it seems to me that scientists, with the special training and talents that they have, should combat, in some form or other, the great anti-intellectual forces which seem to develop almost automatically in a free society.

ELMER HUTCHISSON
American Institute of Physics,
New York, New York

Double Standard?

The recent editorial in *Science* entitled "The Horse's Mouth" [**127**, 57 (1958)], which distinguishes, by inference at least, between the validity of scientific data and the theories logically derived from them and the validity of opinions of scientists concerning the social and other nonscientific implications of their observations, is most timely indeed. Unfortunately, preeminence in science may lend unwarranted weight to the publicized opinions of scientists on completely nonscientific matters regardless of the subject or the qualifications of the individuals who are expressing their views.

Despite the propensity of some members of other professional groups to make ill-considered and inaccurate statements to the public press concerning matters in which they have no special competence, we might reasonably expect scientists, who are supposedly trained in the discipline of objectivity, to restrain themselves in this respect. Unfortunately, this is not the case, as is witnessed, for instance, by the recent address given at the meeting of a national scientific society to the effect that now that man has launched a world satellite, man can dis-

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card the idea of God. Similarly, a Nobel Prize winner in microbiology is currently reported in the public press to have stated that, inasmuch as immortality cannot be demonstrated by science, it cannot be held to be true. That, insofar as the pertinence of scientific data is concerned, these conclusions are *non sequitur,* that the scientific method is not designed to consider these matters, and that the authors of these opinions have no formal knowledge of metaphysics or theology, is little realized by the general public nor, I suspect, adequately appreciated by the authors themselves. However, being human, scientists will very probably continue to release through the public press their private views on any and every subject if given the opportunity, and it is their democratic privilege to do so. Whether they are justified in representing such opinions as "scientific" is quite another matter.

This brings me to the main point of this letter; that is, that in the scientific press, at least, articles expressing personal opinions on nonscientific matters should be so labeled and should be clearly dissociated from objective technical reports and reviews. *Science* and *The Scientific Monthly* [now combined with *Science,* the joint journal continuing in the *Science* format] have been particularly remiss in this respect, due, perhaps, to the broad nature of their coverage. During the last year, for instance, in the journals cited above, there have been published a number of feature articles dealing detrimentally with our traditional systems of politics, morals, and religion. That the intellectual precepts of these aspects of our culture should be critically scrutinized, I grant without reservation. I maintain, however, that we may rightly demand that, even though those who undertake to write on such subjects in scientific journals be eminent scientists, they should still be required to have some competent technical knowledge of their subjects and should treat the latter with the same logic and objectivity that they are required to use in their scientific publications. No journal of ethics or moral philosophy, for instance, would accept some of the articles you have published simply because the authors were renowned biologists or physicists. And of particular importance, incidental private judgments on such matters should not be allowed to appear in articles which profess to be technical in nature. One of your recent features, supposedly a discussion of theoretical biology, contained a diatribe of dogmatic and unsubstantiated statements to the effect that scientists who believe in the reality of supernatural phenomena are schizophrenic in their reasoning, and that such irrational beliefs preclude the scientific study of biological phenomena! This sort of thing has no rightful place in a tecnhical article, whether or not the editors disclaim responsibility for the opinions of the author. Since *Science* and similar journals reject scientific articles and reviews unless evidence is presented substantiating the data presented and the reasonableness of the conclusions drawn therefrom, I urge a tightening of editorial policy to raise the standards of articles on nonscientific matters as well.

William B. Atkinson

College of Medicine,
University of Cincinnati,
Cincinnati, Ohio

Meetings

Montana Academy of Sciences

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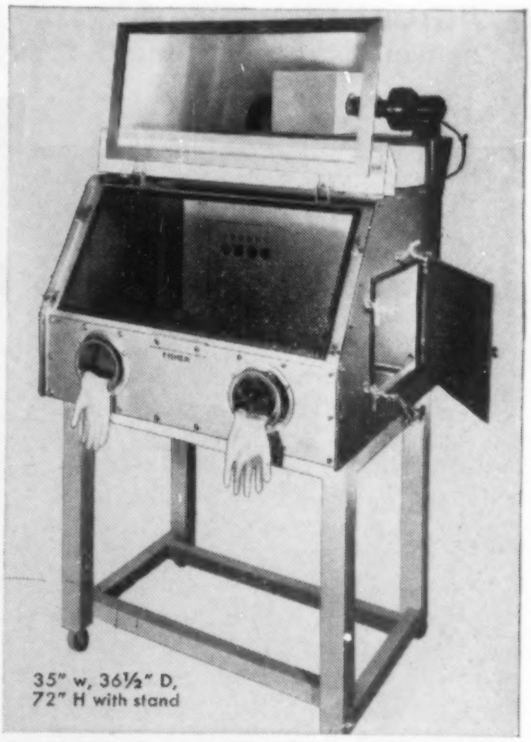

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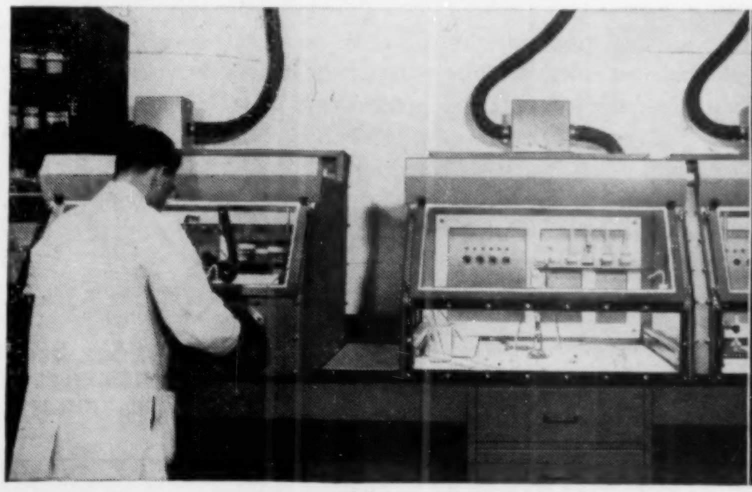

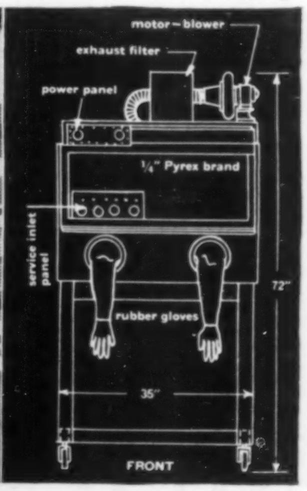

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The members have set as the objectives of their academy the encouragement of scientific work and the dissemination of scientific knowledge. To carry out these objectives the academy holds meetings each year at which the members report on their scientific work and during each of which a lecture, of interest to the members and the general public, is given by an outstanding scientist. A periodical, *The Proceedings of the Montana Academy of Sciences,* which consists of the papers presented at the annual meeting and others considered worthy of publication, is published each year. Three hundred and seventy-two copies of the *Proceedings* are purchased by the libraries of the units of the greater University of Montana and exchanged by them for similar publications. The publications so obtained are a valuable addition to the libraries of the institutions because the scientific work reported in them is made available to scientific workers in Montana.

The academy has recently started a Junior Academy of Sciences, to be made up of junior and senior high-school students interested in science. By this means it hopes to better carry out its objectives, since it considers that this group is the critical one as far as creating interest in science is concerned. The academy hopes to stimulate interest in science among these students by providing them with speakers from the various fields of science; by holding meetings, at which they can report on their own work, in conjunction with the annual meetings of the academy and with the district and state Science Fairs; and by publishing a Junior Academy newsletter. It will continue to award honorary memberships to winners in the Science Talent Search and the State Science Fair as a means of recognizing outstanding work in science by high-school students.

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Society Elections

■ International Association of Milk and Food Sanitarians, Inc.: pres., Harold B. Robinson, Washington, D.C.; pres.-elect, Franklin W. Barber, Oakdale, N.Y.; sec.-treas., Vincent T. Foley, City Health Department, Kansas City, Mo. The vice presidents are William V. Hickey, New York, N.Y., and John J. Sheuring, Athens, Ga. The representative to the AAAS Council is Samuel H. Hopper, Indiana University Medical Center.

■ American Public Health Association: pres., Roy J. Morton, Oak Ridge, Tenn.; pres.-elect, Leona Baumgartner, New York, N.Y.; treas., Charles Glen King, New York, N.Y.; exec. sec., Berwyn F. Mattison, New York, N.Y. The vice presidents are Arnoldo Gabaldon, Maracay, Venezuela; Morley S. Lougheed, Winnipeg, Canada; and Thomas F. Sellers, Atlanta, Ga.

■ Astronomical Society of the Pacific: pres., Nicholas U. Mayall, Lick Observatory; sec.-treas., Sturla Einarsson, Leuschner Observatory, Berkeley, Calif.; assistant sec.-treas., Vera Graves. The vice presidents are Clifton H. Kroll, George W. Hall, and C. Nelson Hackett.

Forthcoming Events

April

10–12. American Assoc. of Physical Anthropologists, 27th annual, Cambridge, Mass. (J. N. Spuhler, Dept. of Human Genetics, Univ. of Michigan, Ann Arbor.)

11–12. Eastern Psychological Assoc., annual, Philadelphia, Pa. (G. Lane, Dept. of Psychology, University of Delaware, Newark.)

12. Society for the Scientific Study of

Religion, New York. (L. Whitman, 297 Fourth Ave., New York, N.Y.)

13–14. American Soc. for Artificial Internal Organs, Philadelphia, Pa. (G. Schreiner, Georgetown Univ. Hospital, Washington 7.)

13–18. American Chemical Soc., 133rd, San Francisco, Calif. (R. M. Warren, ACS, 1155 16 St., NW, Washington 6.)

13–19. Federation of American Societies for Experimental Biology, annual, Philadelphia, Pa. (M. O. Lee, FASEB, 9650 Wisconsin Ave., Bethesda 14, Md.)

14–16. Automatic Techniques Conf. Detroit, Mich. (J. E. Eiselein, RCA, Bldg. 10-7, Camden 2, N.J.)

14–18. American Assoc. of Clinical Chemists, annual, Philadelphia, Pa. (M. M. Friedman, Lebanon Hospital, New York 57.)

14–18. American Assoc. of Immunologists, annual, Philadelphia, Pa. (F. S. Cheever, Graduate School of Public Health, Univ. of Pittsburgh, Pittsburgh.

14–18. American Soc. for Experimental Biology, annual, Philadelphia, Pa. (J. F. A. McManus, Univ. of Alabama Medical Center, Birmingham.)

14–18. American Soc. of Biological Chemists, annual, Philadelphia, Pa. (P. Handler, Dept. of Biochemistry, Duke University School of Medicine, Durham, N.C.)

15–17. Gas Measurement, 34th annual conf., Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

16–25. Instruments, Electronics and Automation Conf., London, England. (Industrial Exhibitions Ltd., 9 Argyll St., London, W.1.)

17–18. Environmental Engineers, 2nd

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annual institute, New York. (Institute of Environmental Engineers, 9 Spring St., Princeton, N.J.)

17–18. Midwest Benthological Soc., annual, Madison, Wis. (K. M. Mackenthun, 453 State Office Bldg., Madison 2.)

17–19. Association of Southeastern Biologists, annual, Tallahassee, Fla. (J. C. Dickinson, Jr., Dept. of Biology, Univ. of Florida, Gainesville.)

17–19. Eastern Colleges Science Conf., 12th annual, Wilkes-Barre, Pa. (Mrs. E. Stevens, Wilkes College, Wilkes-Barre.)

18. Iowa Acad. of Science, annual, Des Moines. (C. H. Lindahl, Dept. of Mathematics, Iowa State College, Ames.)

18–19. Arkansas Acad. of Science, annual, Little Rock. (L. F. Bailey, Botany Department, Univ. of Arkansas, Fayetteville.)

19–20. Eastern Sociological Soc., 28th annual, Philadelphia, Pa. (A. Van der Slice, School of Social Sciences and Public Affairs, American Univ., 1901 F St., NW, Washington 6.)

19–21. American College of Apothecaries, Los Angeles, Calif. (R. E. Abrams, Hamilton Court, 39th and Chestnut St., Philadelphia, Pa.)

19–25. Industrial Health Conf., Atlantic City, N.J. (IHC, Room 1313, 28 E. Jackson Blvd., Chicago 4, Ill.)

20–22. American Assoc. of Colleges of Pharmacy, annual, Los Angeles, Calif. (G. L. Webster, College of Pharmacy, Univ. of Illinois, 808 S. Wood St., Chicago, 12.)

20–22. American Soc. of Hospital Pharmacists, Los Angeles, Calif. (Mrs. G. N. Francke, 1812 Norway Rd., Ann Arbor, Mich.)

20–23. Chemical Engineering Conf., Canada-United States, Montreal, Quebec, (H. R. L. Streight, DuPont Company of Canada, P.O. Box 660, Montreal.)

20–23. Numerical Approximation Symp., Madison, Wis. (R. E. Langer, Mathematics Research Center, U.S. Army, Univ. of Wisconsin, 1118 W. Johnson St., Madison 6.)

20–25. American Pharmaceutical Assoc., annual, Los Angeles, Calif. (R. P. Fischelis, APA, 2215 Constitution Ave., NW, Washington 7.)

21–22. National Assoc. of Boards of Pharmacy, Los Angeles, Calif. (R. P. Fischelis, 2215 Constitution Ave., NW, Washington 7.)

21–23. American Oil Chemists' Soc., Memphis, Tenn. (Mrs. L. R. Hawkins, AOCS, 35 E. Wacker Dr., Chicago 1, Ill.)

21–28. American Industrial Hygiene Assoc., annual, Atlantic City, N.J. (G. D. Clayton, George D. Clayton and Associates, 14125 Prevost, Detroit 27, Mich.)

22–24. Electronic Components Symp., Los Angeles, Calif. (E. E. Brewer, Convair, Inc., Pomona, Calif.)

23–24. Chemurgic Conf., 2nd annual, Chicago, Ill. (Council for Agricultural and Chemurgic Research, 350 Fifth Ave., New York 1.)

23–26. Internal Medicine, 5th internatl. cong., Philadelphia, Pa. (E. R. Loveland, 4200 Pine St., Philadelphia 4.)

23–27. American Assoc. of Bioanalysts, natl., New York, N.Y. (L. D. Hertert, AAB, Suite 1049, 490 Post St., San Francisco 2, Calif.)

24–25. Eastern States Health Education Conf., New York (I. Galdston, New York Acad. of Medicine, 2 E. 103 St., New York 29.)

24–25. Nutrition Conf., 4th annual, Detroit, Mich. (J. M. Orten, Dept. of Physiological Chemistry, Wayne State Univ., College of Medicine, 1401 Rivard St., Detroit 7.)

24–26. American Mathematical Soc., New York. (AMS, 190 Hope St., Providence 6, R.I.)

24–26. International Scientific Radio Union, spring, Washington, D.C. (J. P. Hagen, National Acad. of Sciences, 2101 Constitution Ave., NW, Washington 25.)

24–26. West Virginia Acad. of Science, annual, Morgantown. (M. Ward, Glenville State College, Glenville, W. Va.)

24–26. Wildflower Pilgrimage, 8th annual, Gatlinburg, Tenn. (A. J. Sharp, Dept. of Botany, Univ. of Tennessee, Knoxville.)

25–26. American Assoc. of University Professors, annual, Denver, Colo. (R. K. Carr, 1785 Massachusetts Avenue, NW, Washington 6.)

25–26. Georgia Acad. of Science, annual, Emory Univ., Emory. (M. T. Clark, Chemistry Dept., Emory Univ., Emory, Ga.)

25–26. Kentucky Acad. of Science, Natural Bridge State Park. (G. Levey, Berea College, Berea, Ky.)

25–26. Louisiana Acad. of Sciences, annual, Shreveport. (H. B. Boudreaux, Louisiana State Univ., Baton Rouge 3.)

25–26. South Dakota Acad. of Science, annual, Rapid City. (J. M. Winter, Botany Dept., Univ. of South Dakota, Vermillion.)

27–1. American Ceramic Soc., 60th annual, Pittsburgh, Pa. (C. S. Pearce, ACS, 4055 N. High St., Columbus 14, Ohio.)

27–1. Electrochemical Soc., spring, New York. (H. B. Linford, ES, 1860 Broadway, New York 23.)

27–1. Society of American Bacteriologists, 59th annual, Chicago, Ill. (E. M. Foster, Univ. of Wisconsin, Madison 6.)

27–1. Southwestern and Rocky Mountain Div., AAAS, annual, Las Vegas, N.M. (M. G. Anderson, New Mexico A.&M. College, Las Cruces.)

28–29. Automatic Control in the Petroleum and Chemical Industries, 3rd annual conf., Norman, Okla. (M. L. Powers, Extension Div., Univ. of Oklahoma, Norman.)

28–3. Engineering Societies of Western Europe and the United States, conf. (closed), New York. (C. E. Davies, American Soc. of Mechanical Engineers, 29 W. 39 St., New York 18.)

May

1–3. American Physical Soc., Washington, D.C. (K. K. Darrow, APS, Columbia Univ., New York 27.)

1–3. Kansas Acad. of Science, annual, Ottawa. (C. T. Rogerson, Dept. of Botany, Kansas State College, Manhatten.)

1–3. Midwestern Psychological Assoc., Detroit, Mich. (D. W. Fiske, Dept. of Psychology, University of Chicago, Chicago 37).

1–8. American Soc. of Tool Engineers, 26th annual, Philadelphia, Pa. (ASTE, 10700 Puritan, Detroit 38, Mich.)

2. Engineers and Architects Conf., 5th annual, Columbus, Ohio. (H. A. Bolz, College of Engineering, Ohio State Univ., Columbus.)

2. Southern California Acad. of Sciences, annual, Los Angeles. (Miss G. Sibley, Los Angeles County Museum, Exposition Park, Los Angeles 7, Calif.)

2–3. Minnesota Acad. of Science, Bemidji. (M. R. Boudrye, 51 University Ave., St. Paul 3, Minn.)

2–3. North Carolina Academy of Science, annual, Durham. (J. A. Yarbrough, Meredith College, Raleigh, N.C.)

2–3. North Dakota Academy of Science, 50th anniversary, Fargo. (B. G. Gustafson, Box 573, University Station, Grand Forks, N.D.)

3–4. Population Assoc. of America, annual, Chicago, Ill. (D. O. Price, Inst. for Research in Social Science, Univ. of North Carolina, Chapel Hill.)

4–7. American Federation for Clinical Research, annual, in conjunction with American Soc. for Clinical Investigation and Assoc. of American Physicians, Atlantic City, N.J. (W. W. Stead, College of Medicine, Univ. of Florida, Gainesville.)

5–6. Secondary Recovery Symp., 3rd biennial, Wichita Falls, Tex. (E. O. Kirkendall, American Inst. of Mining, Metallurgical & Petroleum Engineers, 29 W. 39 St., New York 18.)

5–7. American Geophysical Union, 39th annual, Washington, D.C. (W. E. Smith, AGU, 1515 Massachusetts Ave., NW, Washington 5.)

5–8. American Meteorological Soc., Washington, D.C. (K. C. Spengler, AMS, 3 Joy St., Boston 8, Mass.)

6–9. Optics in Metrology Colloquium, International Commission of Optics, IUPAP, Brussels, Belgium. (S. S. Ballard, Scripps Institution of Oceanography, San Diego 52, California.)

6–9. Royal Netherlands Acad. of Sciences and Letters, 150th anniversary, Amsterdam, Netherlands. (RNASL, 29 Kloveniersburgwal, Amsterdam.)

6–9 Western Joint Computer Conf., Los Angeles, Calif. (W. H. Ware, Rand Corp., 1700 Main St., Santa Monica, Calif.)

6–9. International Commission of Optics, colloquium, Brussels, Belgium. (W. D. Wright, Imperial College, South Kensington, London, S.W.7.)

7–9. Acoustical Soc. of America, annual, Washington, D.C. (W. Waterfall, 335 E. 45 St., New York 17.)

7–10. Virginia Academy of Science, annual, Roanoke. (P. M. Patterson, Dept. of Science, Hollins College, Hollins, Va.)

7–11. American Psychoanalytic Assoc., San Francisco, Calif. (J. N. McVeigh, APA, 36 W. 44 St., New York 36.)

8. Association of Vitamin Chemists, Chicago, Ill. (A. E. Denton, Research Labs., Swift & Co., Chicago 9.)

8–9. Colorado-Wyoming Acad. of Science, annual, Denver, Colo. (R. G. Beidleman, Zoology Dept., Colorado College, Colorado Springs.)

8–10. Illinois State Academy of Science, 51st annual, Urbana. (R. A. Evers, Illinois Natural History Survey, Urbana.)

12–14. High Polymer Forum, 8th Ca-

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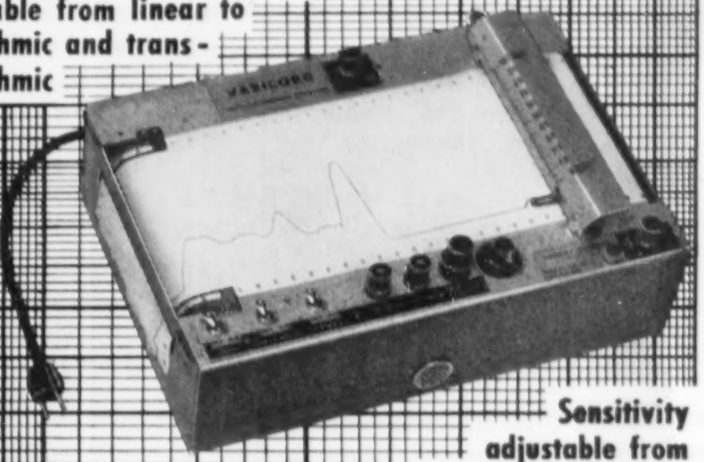

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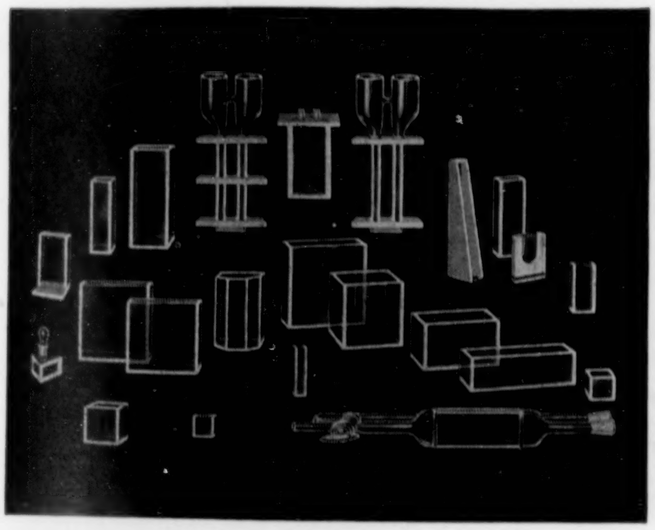

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12–14. Instrumental Methods of Analysis, internatl. Symp., Houston, Tex. (H. S. Kindler, Instrument Soc. of America, 313 Sixth Ave., Pittsburgh, Pa.)

12–14. Research Methods and Instrumentation Symp., 8th annual, Bethesda, Md. (J. B. Davis, National Institutes of Health, Bethesda 14.)

12–16. American Psychiatric Assoc., annual, San Francisco, Calif. (D. Blain, APA, 1785 Massachusetts Ave., NW, Washington 6.)

14. American Acad. of Arts and Sciences, Brookline, Mass. (R. W. Burhoe, 280 Newton St., Brookline 46.)

14–16. Society for Experimental Stress Analysis, Cleveland, Ohio. (W. M. Murray, P.O. Box 168, Cambridge 39, Mass.)

14–24. European Acad. of Allergy, The Hague, Netherlands. (EAA, 17 Emmalaan, Utrecht, Netherlands.)

15–16. Operations Research Soc. of America, Boston, Mass. (M. L. Ernst, Box 2176, Potomac Station, Alexandria, Va.)

15–17. Basal Ganglia Surgery for Involuntary Movement Disorders, symp., New York. (Miss D. P. Frome, Office of Public Relations, New York University-Bellevue Medical Center, 550 First Ave., New York 16.)

18–24. Sanitary Engineering, 6th Inter-American Cong., San Juan, Puerto Rico. (E. Ortega, Box 218, San Juan.)

19–21. American Trudeau Soc., 53rd annual, Philadelphia, Pa. (K. R. Boucot, Woman's Medical College, Philadelphia.)

19–23. Gas Chromatography, 2nd symp., Amsterdam, Netherlands. (G. Dijkstra, Postbox 114, Vlaardingen, Netherlands.)

20–22. Biosynthesis of Terpenes and Sterols, Ciba Foundation symp. (by invitation), London, England. (G. E. W. Wolstenholme, 41 Portland Pl., London, W.1.)

20–24. American College of Cardiology, 7th annual, St. Louis, Mo. (P. Reichert, ACC, Empire State Bldg., New York 1.)

25–29. Air Pollution Control Assoc., 51st annual, Philadelphia, Pa. (H. M. Pier, APCA, 4400 Fifth Ave., Pittsburgh 13, Pa.)

25–29. Institute of Food Technologists, annual, Chicago, Ill. (C. S. Lawrence, IFT, 176 W. Adams St., Chicago 3.)

25–31. International Soc. of Gastroenterology, 3rd world cong., Washington, D.C. (H. M. Pollard, University Hospital, Ann Arbor, Mich.)

26–28. American Soc. for Quality Control, annual, Boston, Mass. (W. P. Youngclaus, Jr., ASQC, 161 W. Wisconsin Ave., Milwaukee 3, Wis.)

26–29. Comparative Endocrinology Symp., Cold Spring Harbor, N.Y. (Symposium of Comparative Endocrinology, Dept. of Zoology, Columbia Univ., New York 27.)

27–31. Thermal and Hydraulic Power Stations, Liége, Belgium. (A. Biron, 1, rue de Spa, Liége.)

28–8. European Federation of Chemical Engineering, 2nd cong., Brussels, Belgium and Frankfurt/Main, Germany. (Deutsche Gesellschaft für Chemisches Apparatewesen, Rheingau-Allee 25, Frankfurt/Main.)

29–31. American Acad. of Dental Medicine, 12th annual, Montreal, Canada. (G. Witkin, AADM, 45 S. Broadway, Yonkers 2, N.Y.)

31–8. European Federation of Corrosion, 2nd cong., Frankfurt/Main, Germany. (Gesellschaft Deutscher Chemiker, Haus der Chemie, Karlstrasse 21, Frankfurt/Main.)

June

2–4. Telemetering Conf., 6th natl., Baltimore, Md. (G. M. Thynell, Applied Physics Lab., Johns Hopkins Univ., Silver Spring, Md.)

2–5. American Nuclear Soc., 4th annual, Los Angeles, Calif. (ANS, P.O. Box 963, Oak Ridge, Tenn.)

2–6. Mass Spectrometry, 6th meeting, New Orleans, La. (R. A. Friedel, U.S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.)

2–6. Medical Library Assoc., 57th annual, Rochester, Minn. (T. E. Keys, Librarian, Mayo Clinic, Rochester.)

2–6. Peaceful Uses of Atomic Energy in Australia, symp., Sydney, N.S.W. (Australian Atomic Energy Commission Research Establishment, Private Mail Bag, Sutherland, New South Wales.)

2–7. Mechanical Engineering, 7th internatl. cong., Scheveningen, Netherlands. (International Mechanical Engineering Cong., 10, avenue Hoche, Paris 8^e, France.)

8–12. Special Libraries Assoc., annual, Chicago, Ill. (M. E. Lucius, SLA, 31 E. 10 St., New York 3.)

9–11. American Assoc. of Spectrographers, 9th annual symp., Chicago, Ill. (H. J. Hettel, Armour Research Foundation, 10 W. 35 St., Chicago 16.)

9–11. Canadian Federation of Biological Societies, 1st annual; with Canadian Assoc. of Anatomists, Canadian Biochemical Soc., Canadian Physiological Soc., and Pharmacological Soc. of Canada; Kingston, Ontario. (E. H. Bensley, Montreal General Hospital, 1650 Cedar Ave., Montreal 25, P.Q.)

9–11. Health Physics Soc., 3rd annual, Berkeley, Calif. (E. E. Anderson, Oak Ridge National Lab., Oak Ridge, Tenn.)

9–11. Soc. of General Physiologists, Woods Hole, Mass. (F. G. Sherman, Dept. of Biology, Brown Univ., Providence 12, R.I.)

9–12. Microscopy Symposium, 5th, Chicago, Ill. (W. C. McCrone, Jr., 500 E. 33 St., Chicago 16.)

9–13. Automation Exposition and Cong., 4th Internatl., New York. (International Automation Exposition, c/o Richard Rimbach Assoc., 845 Ridge Ave., Pittsburgh 12, Pa.)

10–12. Astronomical Soc. of the Pacific, annual, Los Angeles, Calif. (S. Einarsson, Leuschner Observatory, Univ. of California, Berkeley 4.)

10–13. Vacuum Techniques, 1st internatl. congress, Namur, Belgium. (E. Thomas, c/o CSN/ERM, 30, avenue de la Renaissance, Brussels 4, Belgium.)

11–12. Planned Experiment in Chemical Research Symp., Kansas City, Mo. (Chemistry Symp., Midwest Research Inst., 425 Volker Blvd., Kansas City 10.)

Equipment

The information reported here is obtained from manufacturers and from other sources considered to be reliable. Science *does not assume responsibility for the accuracy of the information. A coupon for use in making inquiries concerning the items listed appears on page 662.*

■ MULTIPOINT TEMPERATURE SCANNER checks the outputs of from 4 to 56 thermocouples. If any of the thermocouples indicates a temperature beyond a preset limit, an alarm is sounded and an indicating light corresponding to that thermocouple remains lit. Scanning rate can be as rapid as 0.5 sec per point. (Tipptronic Inc., Dept. S890)

■ STETHOSCOPE is said to allow cardiovascular sounds to be heard approximately twice as loud as those heard through previous instruments. Interchangeable chest pieces permit accentuation of portions of the auscultatory spectrum. Stethoscope length is 20 in. Three sets of ear pieces are provided. (Sanborn Co., Medical Division, Dept. S935)

■ AUTOMATIC TESTER makes 30 wiring checks per minute. The device is capable of selecting a maximum of any five points simultaneously for test. Tests include continuity, condition of wire insulation, and resistance. (Allen B. Du-Mont Laboratories, Inc., Dept. S944)

■ BLADE-EDGE MICROSCOPE is designed to permit checking of leading and trailing edges of turbine blades. In the instrument a narrow band of light defined by a slit is projected obliquely around the edge of the blade to delineate a section. This is viewed obliquely through the microscope in which the elements are so arranged that obliquities cancel out. The resulting image is that of the normal cross section of the blade. Magnification is 40. (Engis Equipment Co., Dept. S952)

■ KINEMATIC-VISCOSITY BATH provides temperature uniformity of ±0.02°F. The bath accommodates Ostwald, Ubbelohde, or S.I.L. suspended-level viscometers. Viscosities from 0.4 to 16,000 centistokes can be measured. Operation below room temperature can be provided. (Precision Scientific Co., Dept. S954)

■ ANGULAR-DISPLACEMENT TRANSDUCER operates on the variable reluctance principle. Rotation of a magnetic rotor varies the amount of ferromagnetic material in a fixed air gap, thereby varying the frequency of an oscillator as a linear function of angle. Ranges are ±4 or ±10 deg. Repeatability error is ± 0.5 percent or less of full range. Full-range frequency deviation falls between ± 6.53 and ± 5.77 percent of carrier. (Ultradyne Inc., Dept. S955)

THICKNESS GAGE measures and records deviations in the diameter of filamentary materials. Rubber pinch rolls draw the material through a light field. Variations in shadow size are detected by phototubes. Range of the device is approximately 0.001 to 0.100 in. diameter. (Industrial Gauges Corp., Dept. S957)

METAL SCREEN manufactured by electroplating has hole diameter of 9 μ. Conical shaped holes are distributed 250,000/in². The screen can be supplied in pure nickel, pure copper, or other base metal and can be chrome plated for abrasion resistance. (Pyramid Screen Corp., Dept. S959)

EXTREME-PRESSURE GAGE measures pressures up to 100,000 lb/in². Each of 1000 indicator divisions can be read to one-fourth division or 250 lb/in². The measuring element, a heavy-walled eccentric tube, is contained within a cast-iron case with sheet-metal backing to ensure operator safety. (American Instrument Co., Inc., Dept. S960)

POWER SUPPLY, transistorized and regulated, delivers 0 to 32 v, 0 to 1 amp. Regulation is better than 0.03 percent or 0.003 v; ripple is less than 3 mv r.m.s. Recovery time is less than 50 μsec. Output voltage is selectable with 0.005 percent resolution; and output impedance is less than 0.01 ohm. (Kepco Laboratories, Inc., Dept. S962)

X-RAY VIEWER enhances contrast of x-ray negatives to assist in interpretation. The viewer consists of a monochrome television monitor console and a flying-spot scanner. The image of the flying spot is focused on a negative which is placed before the scanner. Light passing through the negative is picked up by a phototube. The resulting video signal is fed to the monitor, where a greatly enlarged and contrast-enhanced image is displayed. Negatives may be quickly shifted to view selected areas. (Philco Corporation, Dept. S956)

LIQUID-LEVEL CONTROL operates on the principle that changes of level will change the back pressure of air being bubbled through the liquid. Air pressure in the line to the bubbler is transmitted to a static pressure regulator which in turn repositions a diaphragm control valve. Variation of level is maintained within ± 0.25 in. (Powers Regulator Co., Dept. S964)

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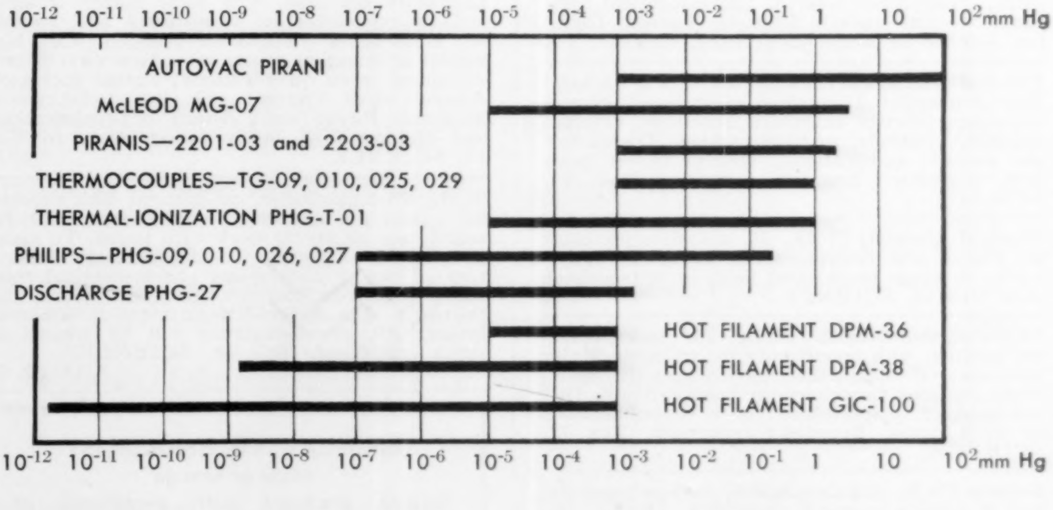

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